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Mass transportation for NPS : a financial feasibility study

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Monterey, California

THESIS

MASS TRANSPORTATION FOR NPS:
A FINANCIAL FEASIBILITY STUDY

by

Paul Bosco

June 1992

Thesis Advisor: William R. Gates

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Mass Transportation for NPS:
A Financial Feasibility Study

by

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of the requirements for the degree of

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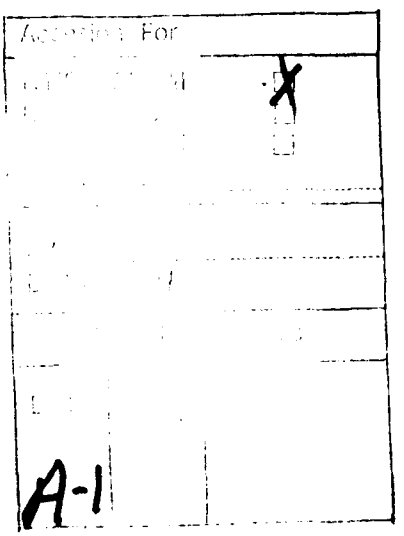
ABSTRACT

This thesis examines the financial feasibility of a shuttle bus for the Naval Postgraduate School (NPS) located in Monterey, California. The current transit system between the student housing area, La Mesa Village (LMV), and the campus loses money and is now on the verge of cancellation.

Research was primarily conducted by survey of the LMV students and compilation of the bus historical ridership/cost sheets. Secondary sources were used to gain insight into civilian intracity transit practices to determine possible shortfalls in the NPS bus service. Also, applicable state and federal environmental regulations were reviewed.

The NPS bus service was found to be financially feasible, though only when NPS enlisted service members are designated as drivers. This is because cash expenditures are not required for their services. All other labor alternatives result in deficits which would require the bus service to be subsidized similar to all intracity bus operations. A reduced fare and increased schedule were shown to enhance revenues.



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I. INTRODUCTION

This thesis analyzes the financial feasibility of providing bus service from a contiguous Naval housing area of 877 units to the main grounds of a graduate education institution, the Naval Postgraduate School (NPS), located in Monterey, California.

A. BACKGROUND

The Naval Postgraduate School has a parking problem [Ref 1: p. 7]. This parking problem was further aggravated in August of 1990 when two new facilities came under construction, a library expansion project and a new academic facility. At that time, in an attempt to mitigate the parking problem, the school administration expanded the existing bus service from two runs a day to hourly bus service from/to the Naval housing area, La Mesa Village (LMV). The Public Works Department (PWD) then transferred responsibility for this bus service to the school's Morale, Welfare and Recreation (MWR) Department. Since its inception, despite various management maneuvers, this bus service has lost money.

Figure 1, NPS area map, depicts the close proximity of the housing area to the school's main grounds. There is only one mile separating the two at their closest points. However, as the housing area expands away from the main grounds, an

additional mile and a half is added. Consequently, the average commuting distance for the residents of La Mesa Village approaches two miles. This distance is far enough away to dissuade the majority of students from walking.

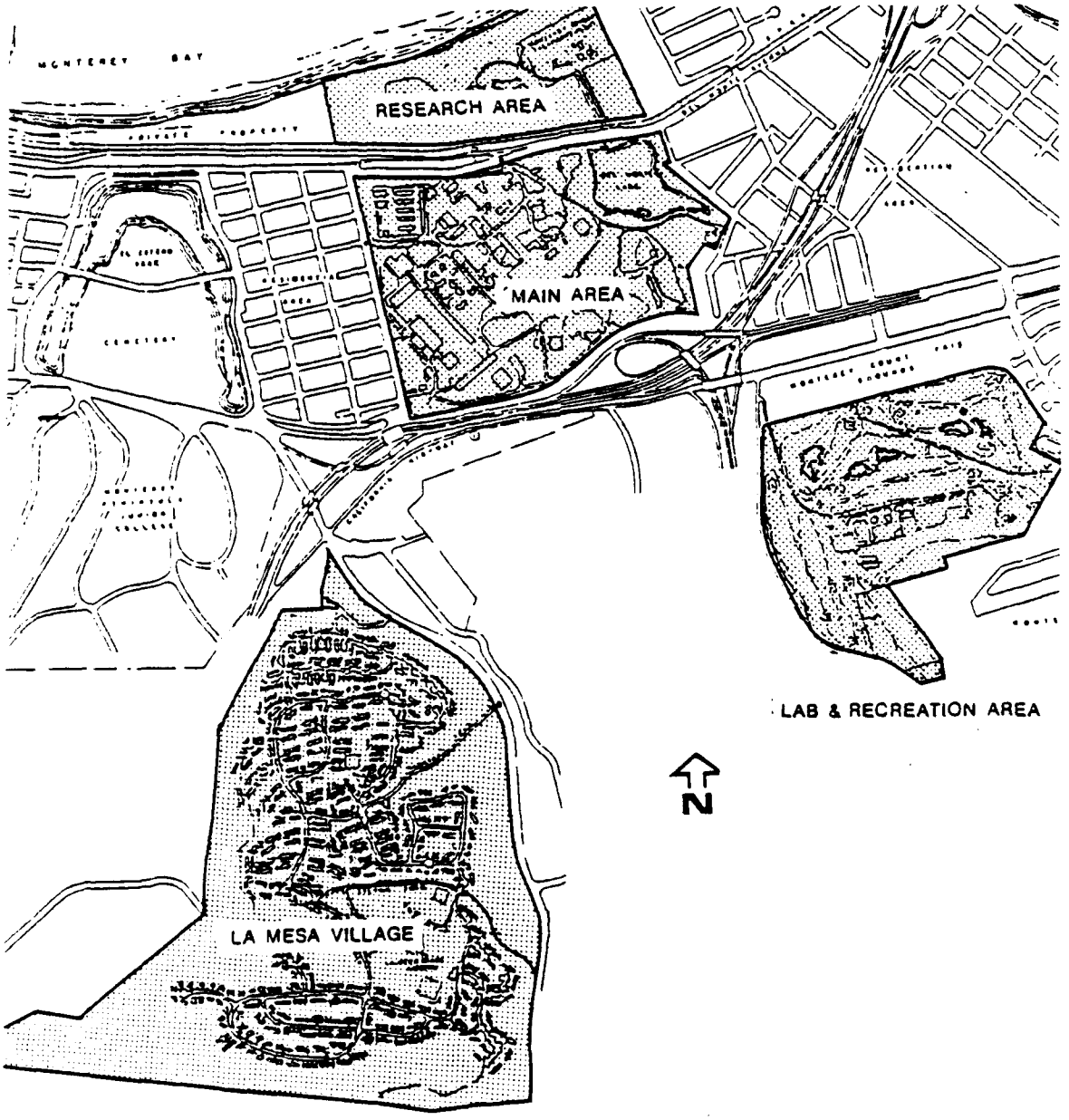

Figure 1. NPS Area Map

Because of the distance, numerous La Mesa Village residents elect to drive their automobile to school. The additional vehicular traffic from La Mesa Village exceeds the parking capabilities at the main campus. As will be shown later, if La Mesa Village residents were not allowed to park on the main grounds during the normal work week, there would not be a parking problem.

There are 877 housing units at La Mesa Village. The residents of this community, with very few exceptions, all work or attend classes on the main grounds. In fact, in May of 1990, students attending the Naval Postgraduate School filled 835 (or over 95%) of these units [Ref. 1: p. 12]. NPS military instructors and staff occupied the remaining units. Although the student population has fluctuated during recent years, from 1600 to nearly 1900 students, the number of military instructors and staff has remained more consistent. Consequently, the composition of residents in La Mesa Village remains fairly constant, despite student population fluctuations and the students' short tenure at school. (The majority of students only remain at NPS from eighteen to twenty four months.)

The majority of students at La Mesa Village have very flexible schedules geared around their unique lecture and laboratory times. This characteristic makes it difficult for them to carpool and also increases the desired number of bus runs from/to LMV. In addition, increased student acquisition

of home personal computers, a national trend, draws students back to LMV at irregular times during the day.

One further characteristic worthy of note is the relative homogeneity and maturity of the student population compared to most graduate institutions. With very few exceptions, every student at NPS is a military officer. Not surprisingly, as the name of the school implies, the vast majority of these are United States Naval officers. In addition, all students arrive at NPS after a number of years of real world experience. The majority of students already have established families. This further aggravates the parking situation since very few reside in the "dormitory" (the Bachelor Officer's Quarters, BOQ), which is within walking distance of the academic buildings on campus. Also, they all have a secure income that allows them to maintain one or more automobiles. Finally, the homogeneity of this population is a point to keep in mind during data analysis and for future marketing plans.

B. OBJECTIVES OF RESEARCH

Given the current parking problems and monetary losses of the existing bus service, this research focuses on the financial feasibility of maintaining a bus system for the residents of La Mesa Village. Specifically, the primary research question is:

1) Is a mass transportation system between the Navy's family housing area, La Mesa Village, and the Naval Postgraduate school in Monterey, California, financially feasible?

Subsidiary research questions include:

1) What Department of Defense (DOD) regulations apply to providing mass transportation for service members?

2) Is there a need and/or demand for mass transportation from/to the Naval Postgraduate School?

3) What are the costs of various alternatives for providing this mass transportation service (e.g., provided by the government, commercial firms or mix thereof)?

4) What is the optimal price the ridership would pay for such a service while maximizing net revenues?

C. LIMITATIONS OF RESEARCH

1. Scope

In addition to analyzing the financial feasibility of operating a bus service for some of the Naval Postgraduate students, this thesis will also recognize the constraints emanating from applicable Department of Defense (DOD) regulations. Consequently, an outline of the various bus services permitted by DOD will be presented. The need for providing a bus service will be documented by quantifying the parking shortfall aboard NPS and addressing the applicable federal and state environmental regulations. The demand for bus service will be derived by sample survey of the residents of La Mesa Village.

Within the arena of federal regulation, the thesis will examine the rules and regulations applicable to city

transit (bus) organizations as well as the environmental implications, both federal and state, associated with the mass transit industry. Of specific interest will be an examination of city transit companies' revenues from fares to gain some insight for improving the Naval Postgraduate School bus operation's financial picture. Also, a review will be conducted of California's 1988 Clean Air Act and the 1991 Air Quality Management Plan (AQMP) drafted by the Monterey Bay Unified Air Pollution Control District.

Utilizing cost information and bus rider numbers provided by the Public Works and Morale, Welfare and Recreation Departments of the Naval Postgraduate School, a financial analysis will be conducted. Revenues will be analyzed based on historical data and also projected based on results of a survey of the La Mesa Village residents. Based of these survey results, a financially optimum bus service will be developed. By maximizing hourly net revenues, perhaps the current deficits being experienced by the MWR Department can be diminished or eliminated. That is the goal.

Finally, the impact of various bus operating parameters, specifically scheduling, routing, timeliness and marketing, will be analyzed from survey results, historical data, and from research conducted from secondary sources. Projected ridership numbers derived from the survey results are contingent on the school providing "acceptable" service. Since revenue is generated from the ridership, and the goal is

to maximize hourly net revenue, it was imperative that these key service parameters be examined to identify areas for improvement.

This thesis will not cover any other alternative forms of local transit which may be appropriate for the Naval Postgraduate School in reducing parking congestion. Specifically, it will not examine the feasibility of carpooling and ridesharing.

2. Assumptions

A number of assumptions are made throughout this thesis that are outlined below.

1) There are no plans to construct any new parking lots given the space, environmental, and fiscal constraints of NPS.

2) The reader of this thesis has a basic understanding of the U.S. military and federal government organizations.

3) The reader of this thesis has a basic knowledge of statistics, economics and managerial accounting.

4) The reader has some knowledge of the sensitivity to environmental issues and of the current efforts to clean up the environment.

D. METHODOLOGY

There were three sources used for this research; secondary sources, survey of La Mesa Village residents and interviews.

1. Secondary Sources

Secondary sources served as the starting point for this thesis. They consisted primarily of textbooks and

Department of Defense and Department of the Navy instructions. Also, transportation journals and magazines were referenced as well as newspaper articles, past studies and reports. Most of the secondary sources were found at the Naval Postgraduate School library, reflecting the fact that this institution offers a transportation logistics degree. The Monterey City library and the Defense Logistics Studies Information Exchange (DLSIE) also proved helpful. Historical cost and ridership data, provided by NPS, was examined and analyzed. Finally, information regarding environmental regulations and air quality standards for the Monterey Peninsula were obtained from the Monterey Bay Unified Air Pollution Control District's 1991 Air Quality Management Plan.

2. Survey

The primary research method used for this thesis was a survey. The survey was directed at a simple random sample of 200 of the 877 occupants of La Mesa Village. The contents of that survey, as well as the raw data results, are provided in Appendix A. The overall survey and sampling plan was accomplished as outlined in reference (2).

A sample of 200 was selected anticipating a return of between fifteen to twenty percent. A returned sample size, n, of at least thirty was desired so that the statistical central limit theorem could be imposed; "in other words, if the sample size, n, is 30 or more, then probabilities for the sample mean

are approximately equal to areas under the normal curve..."[Ref. 3: p. 363] By being able to use the central limit theorem, generalized statements of the population can be inferred from the sample.

A simple random sample was used. Each resident of La Mesa Village had a known and equal chance of being selected [Ref. 2: p. 120]. This was accomplished by obtaining mailing labels from the LMV housing office for each of the residents of La Mesa Village. These were numbered consecutively from 1 to 877. Then a random number table was utilized to generate 200 different numbers within the 1-877 range. These numbers were used to establish a one-to-one correspondence with the numbered address labels for the 200 mailed questionnaires.

The timing and sampling procedures focused on maximizing returns. The questionnaire was purposely delayed until late February 1992, approximately one week after mid terms, so as to avoid a period that would have been especially busy for the recipients [Ref. 4: p. 140]. The questionnaires were mailed to the La Mesa Village residences vice placed into student mail boxes on campus. This was both administratively easier and more convenient for the recipient. Also, by getting the survey into the home, a greater return could be expected because of spouse encouragement, especially from one car families. A preaddressed stamped return envelope was provided to make survey participation that much easier. Finally, "there seems to a prevalent belief among some

research workers that better and more complete returns will be forthcoming if a respondent does not have to identify himself;" therefore, a name was not requested on the questionnaire and a request for the address was left optional [Ref. 4: p. 132]. Overall, this strategy proved successful since eighty seven of the 200 questionnaires (or 43.5%) were returned.

It should be noted that accuracy and reliability derived from the survey is affected by two types of errors: sampling error and data collection error [Ref. 2: p.117]. Sampling error appears anytime less than the entire population is surveyed. It can be controlled and estimated using standard statistical methods. The sampling procedures utilized were selected on this basis so it appears that the sample was representative of the population. However, data collection errors can not be estimated. These errors include poor sample, poor questionnaire format and poorly worded questions that could lead to bias, as well as other factors. Overall, it appears that the data collection errors are minimal. Where bias was suspected will be addressed during the survey analysis.

Finally, there is one other bias prevalent whenever performing surveys, and that exists due to non-responses [Ref. 2: p.82]. For example, is it safe to assume that the non-responses from this bus survey would have answered in a similar fashion as the respondents, or did they fail to

respond because they have no interest or desire for bus service throughout La Mesa Village? No method has been widely accepted for determining whether bias exists in mail questionnaires [Ref. 2: p.83]. Therefore, in analyzing the survey results, the interpretation will be on the conservative end of the spectrum.

3. Interviews

Numerous interviews were conducted for this thesis. Almost without exception, these interviews were conducted in an informal atmosphere and in several instances numerous follow-on interviews were conducted. This style was selected due to the close proximity of all the interviewees and because the primary data to determine the financial feasibility of the bus service would be obtained from historical cost data and survey results. Nevertheless, without the contribution of these interviewees, this thesis could have never been concluded.

Interviews were conducted with representatives of the NPS Public Works Department, the Comptroller Department and the Morale, Welfare and Recreation Department. Interviews were also conducted with representatives from the Transportation Equipment Management Center (TEMC) of the Pacific Division of the Naval Facilities Engineering Command during their site visit in mid February, 1992. Finally, telephonic interviews were conducted with representatives of

the Monterey/Salinas Transit (MST) Company, the Fort Ord bus program manager, the Pentagon parking policy manager, and the Monterey Bay Unified Air Pollution Control District.

E. ORGANIZATION OF THE STUDY

1. Chapter I: Introduction

This chapter describes the rationale for conducting this research and provides background information about the Naval Postgraduate School. It outlines the research questions and explains the methodology in conducting the research.

2. Chapter II: Background

This chapter will examine past bus operations performance at NPS more closely and includes some historical ridership and cost figures. An overview of the city transit industry will be presented to gain some insight on the financial realities within that industry. Finally, Department of Defense (DOD) regulations applicable to operating a bus service will be outlined to provide the reader with the operating constraints for the school administration.

3. Chapter III: Analysis of Need/Demand

The need for bus service to transport students from/to the main grounds of the Naval Postgraduate School will be analyzed. The parking shortfall on board NPS will be quantified and future trends projected. The environmental motivations for operating a bus are examined, particularly with regards to the 1988 California Clean Air Act and the

steps being taken by the Monterey Bay Unified Air Pollution Control District. The impact on energy conservation efforts will also be addressed. Finally, the demand for bus service will be derived from survey results.

4. Chapter IV: Cost and Price Analysis

A cost comparison will be outlined between various methods of bus operation by the government and commercial bus service. Simultaneously, these costs will be weighed against projected revenues based on survey results. The total revenues will be based on the surveyed fare price that resulted in revenue maximization.

5. Chapter V: Schedule, Routing and Service

A price and cost analysis is almost meaningless if poor scheduling, routing and service results in no ridership. For a bus operation to be successful it must meet the needs of its customers. This chapter presents the preferred bus schedule, as indicated by the survey, and discusses bus routing and service implications as enumerated in various secondary sources.

6. Chapter VI: Conclusions and Recommendations

Finally, this chapter ties all the findings together and answers the research questions. Specific recommendations will be outlined, based on the data collection results, to optimize bus service for La Mesa Village residents.

F. SUMMARY

In the final analysis, this thesis will show that there is a definite need and demand for bus service from/to La Mesa Village. The financial feasibility will be less lucid. Despite an apparent monetary loss (on paper) in all cases; in certain instances, actual revenues may exceed actual expenditures. In comparison, no city local transit company is able to cover operating costs (excluding depreciation and capital costs) through fare box revenues alone. On average, somewhere between 50%-60% of operating revenues are derived from various levels of government, not users [Ref. 5: p.147]. An NPS fare, cost, and schedule structure will be recommended that minimizes potential loss. None of this can be possible without first examining past losses of the NPS bus, as well as the Department of Defense framework that such a bus system must operate within.

II BACKGROUND

How effective were the most recent NPS bus operations? Were they inefficient compared to the rest of the industry, intracity transit? Do the Department of Defense regulations promote or discourage domicile to work mass transportation? This chapter will examine these issues.

A. NPS BUS HISTORY

For the past few years, NPS has had bus service between La Mesa Village and campus. Prior to August 1990, this bus service consisted of two runs a day. One run left LMV at 7:30 a.m. enroute to school. The return run left NPS at 5:15 p.m. During this period, the price for the bus was only four dollars per academic quarter [Ref. 6: p. 3]. Consequently, the cost of this bus service, approximately $590 per month, was funded primarily from NPS appropriated funds [Ref. 6: p. 11]. In effect, this bus service was a free good which garnered near capacity ridership despite its infrequent schedule. In August 1990, with the start of construction which reduced available parking on base, this bus service was expanded to mitigate the parking congestion. At this time, a fare structure was devised to recapture the bus operating costs. However, it soon became evident that this bus service

was destined to be a money loser despite numerous scheduling and personnel changes.

This section will examine and compare the three different transportation schemes attempted during the period August 1990 to April 1992 and examine how effective they were. Those three schemes are:

1) Bus A, August 1990 - March 1991: Ten runs/Civilian driver. The bus schedule was expanded to ten runs; running almost every hour with a civilian driver.

2) Bus B, April 1991 - December 1991: Six runs/Seabee driver. The bus schedule was reduced to just six runs, three in the morning and three in the afternoon; and the driver for five of the six runs was a Seabee attached to NPS. One mid day run was made in a van with an MWR civilian employee.

3) Van C, January 1992 - April 1992: Six runs/Van/Civilian driver. Today, this "bus" service is being provided at the same six run schedule, but with a twelve passenger van. The driver is an MWR civilian employee.

In all cases, the fare remained the same, fifty cents per ride. Compared to the previous four dollars per quarter, this represented a 1,475% fare increase [Ref. 6: p. 4]. Given the industry standard for price elasticity, known as the Curtin rule, each ten percent increase in price should decrease the ridership about three percent (or -.3 elasticity). Hard times appeared certain.[Ref. 7: p. 8] Fortunately for NPS, along with the price increase was a service increase, so the effect of price alone cannot be evaluated. Whether riders think a fifty cent trip fare is too expensive will become evident from the LMV survey results.

1. NPS Bus Data Comparison

Table 1 below highlights some key facts. The data is based on weekly ridership/cost reports, omitting four day holiday weeks and finals week. The data was not adjusted to correct for apparent discrepancies at this point.

As is evident, Bus A transported the most students. Since the fares are the same for all bus schemes, this is largely attributed to the hourly schedule. The different schedule of Bus A is compared to the others below. The times indicate hours based on 2400 military time.

Runs	Bus A	Bus B/Van C
1	0700	0700
2	0730	0730
3	0830	0830
4	0930	1515
5	1230	1630
6	1330	1730
7	1430	
8	1530	
9	1630	
10	1730	

This schedule reduction seemed logical since the runs deleted at 0930, 1230, 1330 and 1430 were the least used. However, as indicated by Table 1, it reduced ridership by over 55%. Figure 2 provides the percentage of ridership for each of the runs and bus service.

TABLE 1. BUS DATA COMPARISON

	BUS A	BUS B	VAN C
Avg. Weekly Riders	293	125	102
Daily labor hours paid	8	3	5.5
Hourly Labor Rate	$8.38	$7.66	$6.97
Avg. Weekly Miles	250	180	180
Avg. Weekly Gas (gal.)	43.5	33	22.5
Miles per Gallon (MPG)	5.75	5.45	8
Gas cost (per gal.)	$1.34	$1.34	$1.17
Avg. Weekly Loss	($260)	($97)*	($169)

*Loss is understated; MWR employee not accounted for.

In evaluating the operating costs of the bus operation, only the variable costs were considered. These costs include the hourly labor rate and the gasoline consumption. All other costs were considered fixed, including capital depreciation for the vehicles, management cost, and maintenance cost. Despite the mileage difference inherent in the schedules, routine maintenance would remain fairly consistent since there was only about 1,000 miles per quarter difference in schedule.

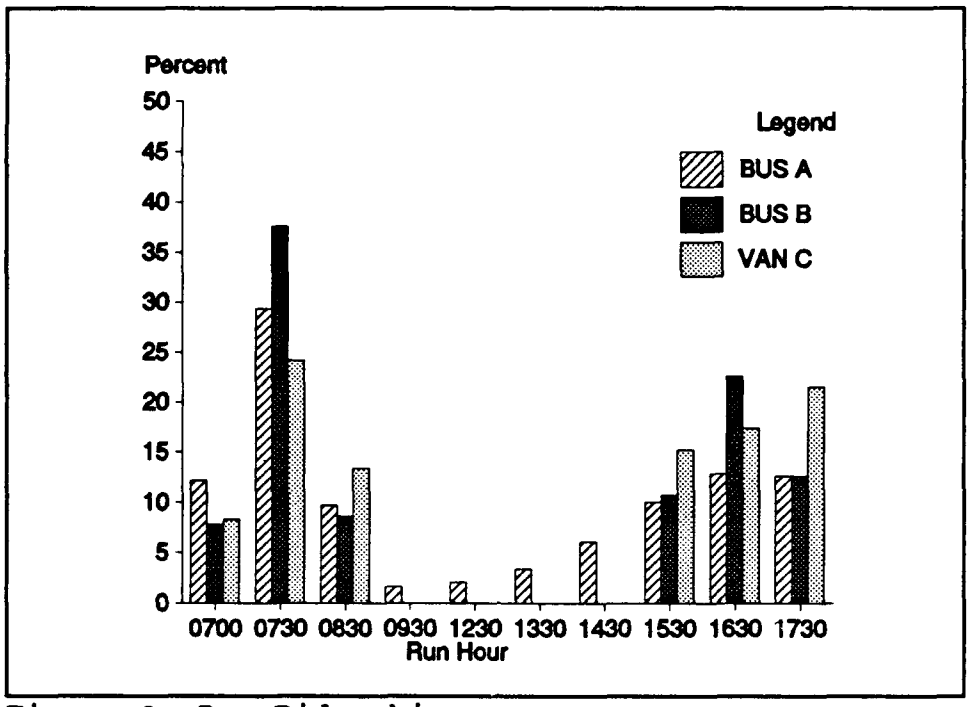

Figure 2. Bus Ridership

One fact rang true when compiling the ridership data; the daily ridership was driven by how many people boarded the bus during the first hour of the day. In all cases, the 0730 hours bus run dominated. When coupled with the 0700 hours bus run, over 70% of all morning riders rode during this first hour. Assuming that most riders that took the bus to NPS in the morning rode the bus back home in the afternoon, it soon became apparent that the first hour of the day forecast the day's ridership. In fact, the majority of the time more people rode the bus in the morning than took the bus back in the afternoon; a 53%/47% split. Another interesting trend was that the afternoon runs were more evenly utilized. There was no dominating afternoon run. Consequently, a filled 0730

hours bus may translate to three separate partially filled afternoon bus runs. This will prove a key fact when addressing future scheduling in Chapter V.

2. Bus Performance Analysis

Based on the data from Table 1, the three different bus operations were evaluated for their effectiveness and efficiency. As Table 2 below indicates, Bus A, the bus operation experiencing the largest losses, proved to be the most efficient and effective bus. These facts were driven by the expanded schedule which generated the highest ridership. (Weekly losses are different between Table 1 and Table 2; the former is calculated from actual historical data, the latter is derived from the variable hourly cost and revenue.)

TABLE 2. BUS PERFORMANCE INDICATORS

	Bus A	Bus B	Van C
Effectiveness People Bussed/Hour	6.5	5.0	4.1
Revenue/Hour	$3.26	$2.50	$2.05
Cost/Hour	$9.67	$9.14	$7.85
(Loss)/Week	($256)	($166)*	($160)
Efficiency Output/Cost	0.67	0.55	0.52

*Adjusted to reflect actual hours worked

As is apparent, effectiveness of transit operations was measured in terms of passengers carried per hour (output), and efficiency by the amount of output per expenditure [Ref. 8: p. 122]. These are accepted measures in the intracity transit industry. Using these measures, Bus A is identified as the best bus system. However, in terms of absolute monetary losses, it lost the most due to its increased operating hours. To see this, compare the percentage of hourly costs covered by hourly revenues for Bus A, B, and C (34%, 27% and 26%, respectively). Bus A is the clear favorite. Thus, Bus A lost the least per hour but had the greatest total loss because it operated more hours. Van C lost to Bus B due to a weekly ridership reduction of 18% after changing the vehicle to a van.

In hindsight, it is evident that the schedule and the type of vehicle had a major impact on ridership. Since the fare remained constant throughout this evaluating period, it had no impact. One common thread for all of these bus schemes was their weekly monetary losses. The trade off became not how effective or efficient the bus service was to be, but loss minimization. Given this trend, cancellation of the bus service would be the optimal solution. But is making a profit the true purpose of an intracity bus service, or is there another motivation? How much profit do they make?

B. CITY TRANSIT INDUSTRY

In 1987, only 37% of the operating costs of all urban bus systems were covered by the revenues from the fare box [Ref 5: p.147]. This fact applies specifically to intracity bus service (urban or local transit), not to be confused with intercity bus transportation (i.e., Greyhound). The gap between operating costs and revenues has been widening since the early 1960's. For example, the Alameda-Contra Costa Transit District (AC Transit), serving the eastern San Francisco bay area and the city of Oakland, saw their revenues as a percentage of operating costs drop from 110% in 1961 to 37% in 1977 [Ref. 8: p. 121]. These operating costs do not include capital costs or depreciation. Similarly, the Southern California Rapid Transit, operating in the Los Angeles area, could only generate revenues representing 35% of their operating costs in 1977 [Ref. 8: p. 121]. This trend has continued downward.

Two local transit companies, the Monterey/Salinas Transit (MST) and the Santa Cruz city bus company, can only cover 30% and 20% of their operating costs, respectively [Ref. 9]. When viewed in this light, the NPS bus system was competitive, especially Bus A, drawing in over 34% of fare revenues to cover its operating costs.

This begs the question, why cannot local transit make money? What is their biggest detractor? Similarly, why operate the bus?

1. The Competition - The Automobile

The automobile is the major source of transportation in the United States. "The trends of the past two decades would lead to the conclusion that in the absence of external constraints such as cost, parking restrictions, changing values and energy shortages, the public will continue to select the automobile."[Ref. 10: p. 49] There are several reasons why people select the automobile over alternative modes of transportation, but six key factors include: economy, comfort, convenience, speed, safety, and individualism [Ref. 5: p. 127].

People believe it is more economical to drive their car. They compare out-of-pocket costs for mass transit and automobiles. They do not factor in wear and tear of the car.[Ref. 7: p. 145] Automobile owners tend to be ignorant of capital costs. Most owners have little idea of what it costs them to operate their cars. Without knowledge of these costs, it is impossible to make a rational choice among alternative means of transportation.[Ref. 5: p. 155] When comparing the average operating cost per trip to NPS of an automobile at fifteen cents to the one way trip fare of the bus at fifty cents, it is clear why the automobile is preferred.[1]

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[1] The average automobile operating cost to NPS was calculated as follows; average one way commute (2 miles) divided by average automobile MPG (approximately 20 MPG) multiplied by a fuel cost of $1.20 per gallon. The average automobile MPG was obtained from 1992 World Almanac.

Fortunately for the NPS bus service, studies consistently show that commuters are far more sensitive to the quality of transportation than to its price. They will give up their cars only if they can dramatically reduce travel time or improve comfort. Factors such as door to door travel time, reliability of schedules, certainty of getting a seat, and others, are important determinants [Ref. 11: p. 72]. Speed is recognized to be the main factor in the choice of travel mode in both the United States and the rest of the world, so the surest way to enable public transport to compete with the private car is to increase its door to door speed [Ref. 12: p. 111].

Given these facts, it is not surprising intracity bus companies are losing money. But how are they able to survive?

2. Urban Mass Transportation Act of 1964

"Cities cannot expect public transit to operate in the red in supplying service which the communities deem essential, unless they are willing to subsidize this service to the extent necessary."[Ref. 13: p. 51] Consequently, in order to keep city buses running, the United States Congress passed the Urban Mass Transportation Act in 1964. This was the real beginning of federal policy in mass transit. This act provided discretionary grants for up to two thirds of the cost of capital equipment and established the Urban Mass

Transportation Administration under the Department of Transportation.[Ref. 5: p. 275]

However, this act proved to be insufficient. Before 1970, most urban transit services were provided by private companies. Today publicly owned transit operations carry the vast majority of the passengers (96%) [Ref. 14]. In 1974, the Urban Mass Transportation Act was amended to allow federal funds to be used to cover up to 80% of capital expenses and to cover up to 50% of operating deficits [Ref. 8: p. 119]. In Monterey, the Monterey/Salinas Transit (MST) adheres to this formula except the majority of the deficit is subsidized from local cities [Ref. 9 and 15].

It should now be apparent that government sees local city transit as a public good providing external benefits for all of society. Besides providing transportation for one car families, the needy, and elderly, it is effective in conserving energy, mitigating traffic congestion and reducing air pollution.

But is this view shared in the DOD arena? Can local DOD activities subsidize their bus operations?

C. DEPARTMENT OF DEFENSE BUS REGULATIONS

The Department of Defense outlines three different types of bus transportation; group transportation, shuttle bus transportation, and mass transit service [Ref. 16: p. 5-1]. These transportation services are summarized below.

1. Group Transportation

The primary reason for establishing this bus transportation is because "commercial transportation facilities are inadequate and cannot be made adequate." [Ref. 17: p. 110] This typically applies to overseas locations, especially third world nations, where local transportation does not meet U.S. standards for comfort and safety. In this instance, bus transportation can be provided for service members at a reasonable fare. This category of bus transportation is not applicable to NPS.

2. Shuttle Bus Transportation

A second category of bus transportation is the shuttle bus. This service is utilized primarily to shuttle personnel within and between local commands, including providing bus transportation for enlisted personnel between troop billeting and work areas [Ref. 17: p. 117]. This service is offered fare free. However, such conveyance may not be used to provide domicile-to-duty transportation. Unfortunately, this prohibition emanates from U.S. law (Title 31, U.S.C. 638a(c)(2)) [Ref. 16: p. 4-1]. Consequently, efforts to establish free shuttle bus service for the La Mesa Village residents would be futile; if established, it would be illegal.

3. Base Mass Transit Service

This bus service may be used between domicile and duty locations, but must charge a fare to recover all costs of providing the mass transportation service. "If, the vehicle is used for both operational (mission) and mass transportation, only the costs directly related to mass transportation must be recovered."[Ref. 17: p. 113] Since both NPS buses (a thirty six passenger and a forty four passenger bus) have been validated on the activity's equipment allowance to support their mission, only labor and gas costs, the direct cost of operations, need to be covered by revenues. Additionally, if an NPS enlisted service member is driving the bus, then the cost of the gas is the only actual expenditure against the station's budget. However, when computing the actual cost of operation, the enlisted service member's equivalent hourly wage may have to be reflected, on paper.

Establishment of base mass transit services requires Chief of Naval Operations (CNO) approval, with endorsements from the command's Transportation Equipment Management Center (TEMC) and the Naval Facilities Engineering Command (NAVFAC Code 164). For such a system to be established, it must be shown that there exists a potential for saving energy and for reducing air pollution and that private companies have been induced to provide such transportation and have declined. Also, it must be shown that the activity will make the most

proper and efficient use of its transportation assets.[Ref. 17: p. 112]

It appears evident that the only bus service applicable to the LMV/NPS case is base mass transit. As will become evident in Chapter IV, the revenues generated from such a bus service will cover the actual expenditures for gasoline but, similar to intracity bus operations, will never cover the total operating costs of labor and gasoline. This is not surprising since, as late as 1987, labor costs accounted for an average of 70.6% of the total cost of intracity bus operations [Ref. 5: p. 148]. What is not so clear is the federal government's position on mass transportation. Why is it acceptable for the federal government to heavily subsidize intracity bus transportation, but to insist on fares covering all costs for DOD domicile to duty transportation?

D. SUMMARY

As demonstrated, the historical data of the NPS bus operation is consistent with the financial performance standards of the intracity bus industry. Both must be heavily subsidized to survive. One point of contention for the NPS bus service is whether actual revenues need only cover actual expenditures. This becomes a poignant point if NPS enlisted drivers are utilized vice civilian hires. Although there is a paper (opportunity) cost for the enlisted member, no actual expenditure against the station funds is made. If losses are

inevitable, can the deficits of a bus service be subsidized by other programs? This possibility is addressed latter in this thesis.

One surprise from a review of the historical data was the fact that Bus A, the bus service offering the most frequent runs at the greatest monetary loss, was the most efficient and effective bus service. Consistent with mass transportation literature, service and schedule seemed to be the paramount factors determining ridership. With a reduction in schedule and a further reduction in service, from a bus to a van, ridership fell. What is yet to be hypothesized is whether a reduced fare under scheme A would have, in fact, generated more revenues because of an increase in ridership.

Knowing that a bus service is a losing proposition, it must have some other inherent value to society for it to be viable. There must be a perceived need and/or demand for a bus service to be successful. This need and demand for an NPS bus service is evaluated in the following chapter.

III. ANALYSIS OF NEED/DEMAND

To be successful, a bus service must satisfy a need and/or demand. This chapter will examine whether bus service is compatible within the NPS/LMV environment and whether the students would ride a bus.

A. THE NEED

1. Parking Shortfall

The current NPS Master Plan (submitted in 1983) identified a shortfall of over twenty percent in terms of required paved parking lot square yardage [Ref. 18: p. IV-15]. At that time, 1,291 students were attending school [Ref. 18: p. I-2]. More recently, in May 1990, the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) conducted a traffic engineering study. There were 1,643 students attending NPS at that time and 1,703 parking spaces identified. In addition, there were 1,442 NPS faculty and staff with an additional 150 personnel assigned to tenant commands [Ref 1: p. 12]. By 1991, the student population had grown to 1,856 and the number of parking spaces had decreased by 240 spaces [Ref. 6: p. 2].

Appendix B depicts the parking lot locations as well as the road and major building locations. At the time of the MTMCTEA study, all the lots depicted in Appendix B were open.

As an indication of parking space deficiency, the study team monitored percent usage of all the lots. Additional parking spaces should be considered when parking lots exceed 85% usage for short-term parking (a few hours or less) and 90% usage for long-term parking [Ref. 1: p. 43]. Overall, the base lots were 91.1% filled in the morning. However, all the student lots closest to the academic area (i.e., Root, Halligan, Spanagel, Bullard and Ingersoll Hall) were over 99% filled, including Lots A, A-1, A-A, Q and R. (The other adjacent lots are for faculty.) Lot U, a dirt lot which was never counted as a parking asset, averaged over 129 parked cars. Since the study's completion, 240 spaces were lost, as previously noted, in Lot Q and Lot V. Lot U was also permanently lost to construction.

In the fall of 1991, the city of Monterey established a new parking ordinance. It allowed only one hour parking on the west side of Sloat Avenue and throughout the adjacent residential neighborhood of Oak Grove. Although difficult to quantify, this action is estimated at eliminating over seventy spaces.

In aggregate, NPS has experienced a reduction of nearly 450 parking spaces since the spring of 1990. Even at that time, parking was identified as a problem. In the fall of 1991, to try and combat this major parking shortfall, the administration temporarily opened up parking on the grassy areas adjacent to some base roadways; particularly, along

Morse Drive, Lake Drive and the western edge of Del Monte Lake. (Refer to Appendix B.) By observation, on three separate mornings in early March 1992, there was an average of 180 cars parked along unpaved areas of Morse Drive alone. Additional cars were later observed along unpaved sections of Lake Drive and along Del Monte Lake. Despite the suboptimal conditions and negative environmental impact, this temporary parking policy has helped. By empirical observation, grass parking appears to provide approximately 250 parking spaces. This helps reduce the shortfall.

This temporary parking measure is still in force today. Unfortunately, the effect it has had on reducing bus ridership is difficult to quantify. Ridership for all types of public transportation decreases as the availability of parking increases [Ref. 19: p. 3-7].

More relevant is what can be anticipated when this temporary measure is lifted. Even when the construction projects are completed, the majority of lost parking spaces will not be returned. Lots Q and V will return approximately half of their original number, for a total of about 130 parking spaces. Lot U and Oak Grove are permanently lost. Potential spaces could be obtained with the demolition of some facilities in the northwest corner of NPS. However, more spaces will be lost within Lot R and along West Road when construction begins on a new Mechanical Engineering facility

in 1993. Unless new parking lots are constructed, NPS will always be tight on parking.

NPS's parking shortfall was further validated by the survey. Despite the temporary parking provision still in effect, over 89% of those responding evaluated the parking facilities on campus as less than good. Over 44% of the respondents classified it as poor. Given this response, it is not surprising that the La Mesa Village students are finding other modes of transportation to school.

2. La Mesa Village Residents

Approximately half of La Mesa Village students have found alternatives to private automobiles for commuting to school. Only 48% of those surveyed use their car as the primary source of transportation. Generalizing those results to the La Mesa Village population, between 37% and 58% of the residents drive their cars to school, at a 95% confidence level.[2] At a minimum, there are 325 extra cars parking on campus from LMV, just enough to exceed the base parking space capabilities. As the table in Appendix A shows, other LMV residents walk, bike, motor bike, car pool or take the bus.

Perhaps the best indication of the need for bus service was the percentage of LMV families with only one car, as reflected in the survey. Surprisingly, 42% of the

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[2] Throughout this thesis, when generalizing sample results to the population, a 95% confidence level was used.

residents sampled have only one car. Generalized to the population, somewhere between 32% and 52% of the LMV residents have one car; or between 280 and 456 families. Table 3 below differentiates the various modes of commuting to school between one car and multiple car LMV families.

TABLE 3. MODES OF TRANSPORTATION

Mode of Transportation	One Car	Two+ Cars	Total
Automobile	22%	66%	48%
Walk	47%	11%	26%
Bicycle	19%	15%	16%
Motor Bike	6%	2%	4%
Carpool	3%	2%	3%
Bus	3%	4%	4%

The most striking contrast above is between one car and multiple car walkers and car drivers. As evident, the majority of one car students have found other means of transportation. Using a point estimate from the survey data, only about eighty students from one car families drive to school. In contrast, a population point estimate reveals that 336 students from multiple car families drive to school. The

target audience for bus service is apparent. Not only are there eighty students that need a ride to school, allowing their spouse the use of their car, but there are hundreds of other students from two car families who may elect to abandon their car given the right bus service.

It should be noted that potential bus riders from both the single and multiple automobile communities of Table 3 are reduced when cross referencing the responses against question four of the survey. By purging out those responding that they would never ride the bus (question four), the single automobile car commuters would be reduced by 25%. Similarly, the multiple car commuters would be reduced by 21%. This still results in a sizeable market for bus service. Using the survey point estimates, sixty single car students need a ride and 265 multiple car owners would be amenable to ride the bus. Of course, as the operating parameters are delineated (schedule, price, route), this market will contract.

Finally, the very fact that NPS is a college makes it compatible for local transit [Ref. 19: p. 3-8]. Other compatibility factors that support an NPS bus service are residential and employment population densities. Concentrated employment areas offer the greatest opportunity to generate ridership. NPS proper exceeds the density threshold of fifty to sixty employees per acre for employment densities and LMV exceeds the residential threshold criteria of four to seven units per acre.[Ref. 19: p. 3-6]

3. Environmental Impact

a. Air Quality Standards

The Monterey Bay is in an air quality nonattainment area. Under the 1988 California Clean Air Act, districts in nonattainment areas are responsible for developing and implementing the transportation control measures necessary to achieve the state ambient air quality standards [Ref. 20: p. 2-4]. The Act makes two major changes to past clean air policy. First, it requires steady progress towards clean air standards, a five percent reduction in emissions per year. Second, it requires local air districts to submit plans to achieve that reduction by cutting traffic.[Ref. 21]

Since the Monterey Bay district cannot meet the air quality standards prior to December 31, 1997, its air pollution is considered serious [Ref. 20: p. 2-7]. One of the most persistent pollutants is ozone. "Ozone is a colorless, odorless gas produced by a photochemical reaction between sunlight and certain emissions, mostly from automobiles."[Ref. 21] The California Air Resources Board estimates that cars and trucks contribute almost half of the emissions linked to ozone and over 80% of carbon monoxide (CO) emissions. California's trademark blend of sun and temperature inversions (which create stagnant air) are prolific smog producers. Even short trips contribute to the air pollution. In fact,

starting a cold car engine emits more pollution than driving ten miles.[Ref. 21]

Recent legislation addresses the contribution of motor vehicles to air pollution by mandating programs to promote alternatives to single occupant automobile trips. The 1988 Clean Air Act requires that air pollution control districts enforce transportation control measures for serious air pollution areas necessary to attain air quality standards. These measures are meant to reduce the rate of increase in passenger vehicle trips and miles traveled per trip. Transportation Control Measures are defined in the act as "...any strategy to reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling or traffic congestion for the purpose of reducing motor vehicle emissions."[Ref. 20: p. 11-27]

After the passing of California proposition 111 (The Traffic Congestion Relief and Spending Limitation Act, which addresses both traffic congestion and air quality problems), cities have until December 31, 1992 to adopt source specific regulations or ordinances, such as trip reduction ordinances [Ref. 20: p. 11-31]. The local cities surrounding NPS at this time are in the process of formulating traffic ordinances along with the Monterey Bay Unified Air Pollution Control District [Ref. 9].

As is evident, the serious air pollution surrounding NPS makes programs necessary that encourage

alternatives to single occupancy vehicular traffic. Walking, biking, carpooling and bussing are all alternative forms of transportation that together will help meet the air quality standards. More sensitive controls include establishing paid parking and not correcting parking shortfalls so as to discourage automobile transportation. Once again, California appears to be leading the way into the next generation of environmental conscientiousness and commuting culture.

b. Energy Conservation

Transportation accounts for 66% of this country's petroleum usage. In 1986, motor fuel accounted for 78.5% of transportation petroleum [Ref. 5: p. 53]. The U.S. will remain sensitive to fluctuations in oil prices if efforts are not continually made to reduce energy consumption. In this vein, buses are eight times as efficient as automobiles based on actual computed load factors [Ref. 5: p. 53].

At NPS, a reduction in vehicular traffic to campus can help. Given that the bus gas efficiency is approximately five miles per gallon (from the empirical evidence derived in Chapter II) and the 1989 average fuel rate for an American passenger vehicle is twenty miles per gallon; it is apparent that only four riders per bus trip constitutes a break even point in terms of fuel consumption [Ref. 22]. This was exceeded for two of the three bus schemes addressed in Chapter II (Bus A and Bus B). Of course, any changes to the bus

service that results in increased ridership will further help energy conservation efforts.

B. THE DEMAND

To derive the demand for bus service, question fourteen of the bus survey was asked, "Do you think we should have bus service to La Mesa Village?" Of the seventy six respondents, 72% gave a resounding yes. Another 9% were borderline, leaning more towards yes than no. Only 18% of those responding replied in the negative. Generalizing these results to the population indicates that between 73% and 90% think that a bus service should be provided between NPS and LMV, at a 95% confidence level. Clearly the residents of La Mesa Village think bus service is in order. The more relevant question is whether they would ride the bus.

Based on question eleven of the survey, "What percentage of the time would you ride the bus given acceptable service and price?," seventy three personnel responded. After purging out those that indicated that they would never ride the bus (question four), sixty five personnel remained. Generalizing this point estimate to the population suggests that between 65% and 85% of the residents of LMV would be willing to ride the bus at some point provided it had an acceptable schedule and price.

This last point is key since the potential range of ridership, 565 to 744, only applies to an ideal world. It

greatly overstates the true potential ridership. Its significance lies in the fact that a vast majority of the residents of LMV display a desire to have bus service between LMV and NPS. Actual bus ridership would be determined based on several factors including the price, schedule, route and advertising. However, as will be shown in Chapter V, NPS does not have the bus assets to accommodate more than 144 students per day (271 daily paid trips) given the historical data of Bus A.

The support for an NPS/LMV bus is surprising, especially when analyzing the data from question one of the survey. Over 73% of those sampled indicated they had never ridden the current bus. Thus, between 65% and 83% of LMV students have never set foot on the bus. This about face is striking. The current bus system apparently does not suit the needs of the majority of LMV residents.

Dissatisfaction with the current bus system was confirmed by responses to questions two, four and five of the survey. Between 50% and 80% are not satisfied with the current bus service. The biggest reason for this dissatisfaction is the schedule. Between 49% and 70% of the population would state that the schedule was not suited to their needs. This was validated by question five that rated schedule last among all other factors.

Similarly, the displeasure with the current fifty cents fare was evident in both questions four and five. Price rated

as the second biggest reason why LMV residents do not ride the bus. The real challenge is to uncover the mix of schedule and price that brings in the highest net revenues. This will be attacked in Chapters IV and V.

C. SUMMARY

There is a definite need and demand for bus service between LMV and NPS. The NPS/LMV environment is compatible for bus service. A parking shortfall on the campus and a high percentage of students from one car families support the need. In addition, today's environmental realities demand that action be taken to curb vehicle emissions. This will require a progressive view and strong leadership. A comprehensive plan to reduce single occupancy vehicles from commuting to NPS is needed. Part of this plan should include bus service.

The residents of LMV want to see bus service continue. They point to several current deficiencies that dissuade them from riding. A poor schedule and high price are the biggest reasons keeping potential riders off the bus. However, the potential for increased ridership is encouraging. Even the healthy response from the bus survey, with eighty seven of two hundred questionnaires returned, is a solid indication that the LMV residents want bus service.

It is evident that the key to increasing revenues for the bus is improving the schedule and altering the fare structure.

Can it be that a reduction in the fare will result in an overall increase in revenue? That is the topic of Chapter IV.

IV. COST AND PRICE ANALYSIS

Can the NPS bus fare structure ever recover all costs? If not, is it possible to subsidize the bus service by some other NPS program? What is the optimum fare that will maximize average hourly net revenue?

The goal of this thesis is to uncover the bus scheme (i.e., price, schedule, driver) that provides the highest average hourly profit (or minimal loss) based on survey results and historical evidence. Bus operating efficiency and effectiveness are secondary considerations. Also, since overall weekly profit (loss) is a function of number of operating hours, it is not a prime focus of this thesis. Due to the potential high ridership numbers alluded to in the previous chapter, van service is not considered. An effective bus service that operates at the lowest hourly cost with the highest average hourly net revenue is the optimal bus scheme.

A. COST OF BUS SERVICE

As was shown in Chapter II, there was only a 19% hourly cost reduction between the most expensive bus (Bus A at a cost of $9.67 per hour) and the least expensive service (Van C at a cost of $7.85 per hour). The most costly bus service also proved to be the most effective and efficient in terms of riders moved per hour at least cost per person. Bus A also

brought in the most revenue. Consequently, revenue maximization vice cost minimization will be the primary focus in this chapter, given the relatively fixed cost structure. Nevertheless, a quick examination of various cost options are in order to compare commercial versus in house sourcing.

As stated earlier, the Navy's transportation manual requires recovery of all costs of operation to operate a base mass transportation service. In this case, the Navy's use of the word cost appears synonymous with expenditure. In the required base mass transit annual report, the format requires that "expenditures" be deducted from total receipts.[Ref. 17: p. 116] This is an important point, since the word cost has a much broader meaning than the word expenditure. Whereas cost can include items which do not require an actual transfer of cash (i.e., opportunity cost); expenditure is defined as "payments of cash for goods and services."[Ref. 23: p. 773] Specifically, this distinction will prove critical in selecting a bus driver.

Table 4 below outlines the expenditures associated with various alternatives. These expenditures are associated with a system similar to Bus A in Chapter II. This service offers ten runs and requires a bus driver for eight hours.

TABLE 4. BUS COST OPTIONS*

	Driver	COST				Total
		Bus	Labor	Gas	Maint	
NPS Government Run	Military	0	0	190	42	232
	MWR	280	1340	190	42	1852
	Civilian	0	1896	190	42	2128
Commercial Lease		1471	1340	190	0	3001

* Costs are expressed in dollars per month

1. Labor Cost

As is obvious, a bus service driven with NPS enlisted service members requires the least cash outlay. In fact, this is the only scheme where actual revenues exceed actual expenditures. This applies not only to the projected revenues derived from the surveys (yet to be addressed), but also to all the previous bus schemes outlined in Chapter II. If a cost for the military driver was mandated, it would result in an increase of $1,665 to the total cost. (As outlined in the Navy Comptroller's Manual, the composite military rate for a seaman, E3, is $10.41 per hour. This rate multiplied by a forty hour week times four weeks results in the monthly labor figure.)[Ref. 24] The $1,665 cost for the military driver would still be cheaper than an NPS civilian wage grade

employee (using a WG-6 at $11.85 hourly wage), but slightly more expensive than an MWR employee.

When adding in military expense, none of the bus cost options would be covered by fares alone. Since the expense for military members does not yet have to be reflected by the station, this thesis will not project military labor as an expenditure. It should be noted that under the DOD financial plan being developed, called DBOF (Defense Base Operating Fund), military salaries would have to be deducted from station funds. In this case, military labor costs would be included as a bus system expense. This is not projected to happen until fiscal year 1994.

MWR has a lower pay rate structure than the civil service. However, since MWR is a tenant to NPS, it would be required to pay the school a monthly bus reimbursement. That rate is $280 per month, at this time [Ref 25]. One note of caution; by Navy instruction, MWR is prohibited from providing "transportation between domicile and place of employment" or "transportation for official business not associated with recreation programs."[Ref. 26] Although this does not appear to be a legal restriction, as providing free domicile to duty transportation, it is worthy of attention.

2. Commercial Bus Options and Costs

Although there was an initial plan to examine all the possible commercial bus schemes, this was abandoned when it

became apparent that there would be no capital charge for the use of the station buses. As mentioned in Chapter II, by Navy regulation, if the bus assets of the station were required to fill some other mission requirements, cost for these buses would not have to be reflected as an expenditure towards base mass transportation operations. When comparing the Navy's standard bus lease rate of $1,471 per month against a zero charge, the commercial options were abandoned [Ref. 27]. Adding in the lowest conceivable labor rate, that of the MWR employee, made the commercial source even less competitive.

Telephonic interviews confirmed this belief. The Fort Ord contracted shuttle bus employees are paid an average wage of approximately twenty dollars per hour. Furthermore, the Monterey Salinas Transit (MST) expressed no interest in establishing a route throughout LMV, at this time.[Ref. 9 and 28] (The MST company did express an interest in competing in any future contracting action for bus service.) Consequently, none of the commercial sourcing options proved competitive with an NPS in-house service.

3. Maintenance and Gas

Concerning vehicle selection (i.e., bus versus van), "One of the established principles of public transport operations is that large vehicles are more economical to operate than small ones with over two thirds of bus operating costs being due to labor."[Ref. 12: p. 115] The historical

data outlined in Chapter II bore this out. The van proved the most inefficient and ineffective option, despite having the lowest labor and gas rates.

One fact rang true for all the bus schemes, since the marginal cost to add an extra run each hour was only about one dollar (the extra gas cost, estimated at a $1.10 per gallon), it would be advantageous to double up bus runs during high peak periods to increase overall revenue. One complete bus cycle, on average, takes twenty to twenty five minutes. Therefore, two runs per hour is feasible.

Throughout this thesis, the routine maintenance cost for the vehicles was assumed to remain constant despite the varying number of bus runs. Since one complete bus cycle through LMV and back is less than five miles, the route and run variations per quarter would not significantly add to the vehicle mileage, especially since two NPS buses would share the load. The maintenance costs outlined above were derived from an estimated annual bus routine maintenance cost of $500 [Ref. 29].

All further discussion in this chapter will focus on bus service assuming an hourly bus schedule similar to Bus A.

B. BUS PRICE AND REVENUES

This section will focus on a fare structure that maximizes revenue. This was derived from the survey, primarily from question twelve. (Refer to Appendix A.) Table 5 below

provides those results in a different light, showing three different methods to highlight the central tendency. These results are derived from the unbiased tables in Appendix A, question 12. They disregard the zero responses.

TABLE 5. SURVEY PRICE RESULTS

	Daily	Weekly	Monthly	Quarterly
Sample Size	39	32	39	37
Average	$0.30	$1.85	$6.36	$14.64
Sample STD	$0.13	$0.77	$3.41	$6.72
Median	$0.25	$2.00	$5.00	$15.00
Mode	$0.25	$2.00	$5.00	$10.00

As will become readily apparent, LMV residents find the current price of fifty cents per one-way trip exorbitant. Although there appears to have been some bias in the responses to question twelve, introduced by the example price structure provided, this was reduced by disregarding responses that merely checked the line adjacent to the example price. A price had to be spelled out to be accepted as responsive. This correction is incorporated in the unbiased results tables

in Appendix A. These corrected results are used to formulate future price structures and revenue projections.

Fortunately, in the case of the daily fare, the example price (fifty cents per day) was not the most popular choice. The example price was the most popular in all the other cases. The daily fare serves as the foundation for the revenue projections. Prior to an analysis of price, the preferred method of payment is reviewed.

1. Fare Structure

As the results of question thirteen indicate, 74% of those surveyed would prefer to pay by pass, either monthly or quarterly. The current method of payment, coupon books, was supported by approximately 21% of the respondents while pay as you go received 18% support. Despite the directions offered by question thirteen, fourteen of the seventy seven respondents indicated multiple choices, resulting in a greater than 100% response. Nevertheless, the desire to have a pass fare structure is worthy of note because one does not exist now.

2. Bus Trip Price

Due to the potential bias inherent in the other price categories, the daily price response received the closest analysis and scrutiny. As Figure 3 depicts, the unbiased and biased results for the daily one way trip fare highlight twenty five cents per trip as the clear favorite.

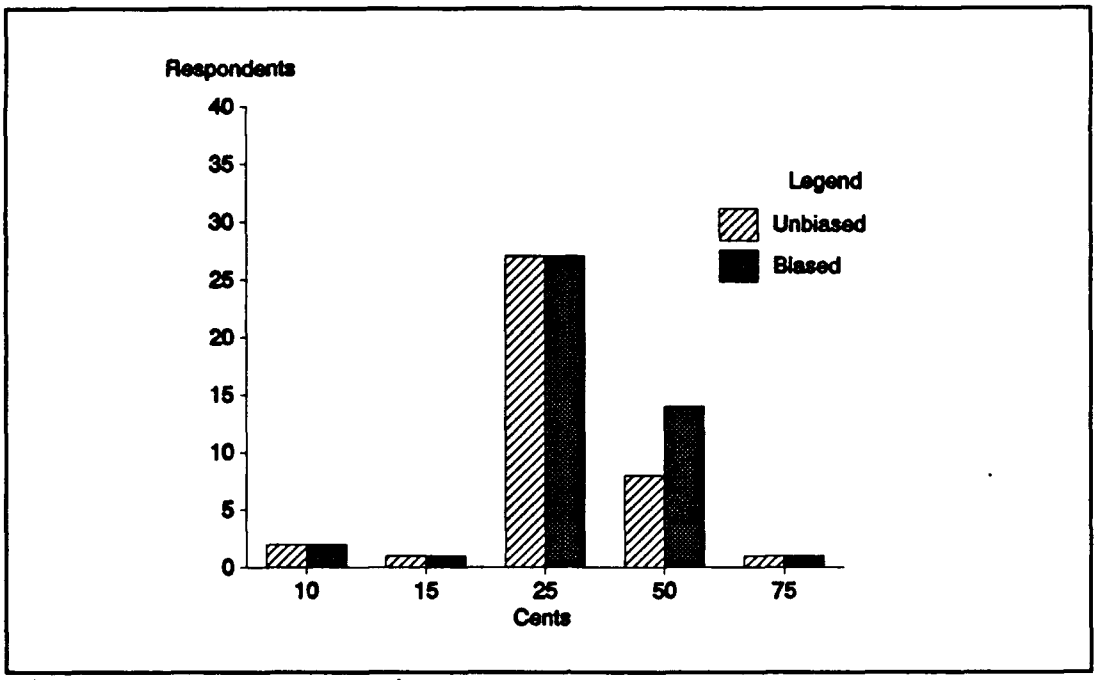

Figure 3. One Way Trip Fare

Figure 4 projects revenues for various trip fares. These revenues were calculated by multiplying the fare price by the number of potential riders (all those that responded to that specific fare price plus the cumulative total of all those that responded to a higher fare). For example, in the unbiased results, the revenues projected for a fifty cents fare would be calculated by multiplying fifty cents times nine (the number of fifty cents respondents plus seventy five cents respondents).

Evaluating both the biased and unbiased results led to the same conclusion. Based on the sample survey results, a twenty five cents trip fare will bring in more revenues than the current fifty cents fare. In fact, the unbiased results suggest a 100% increase in revenues compared to the old fifty

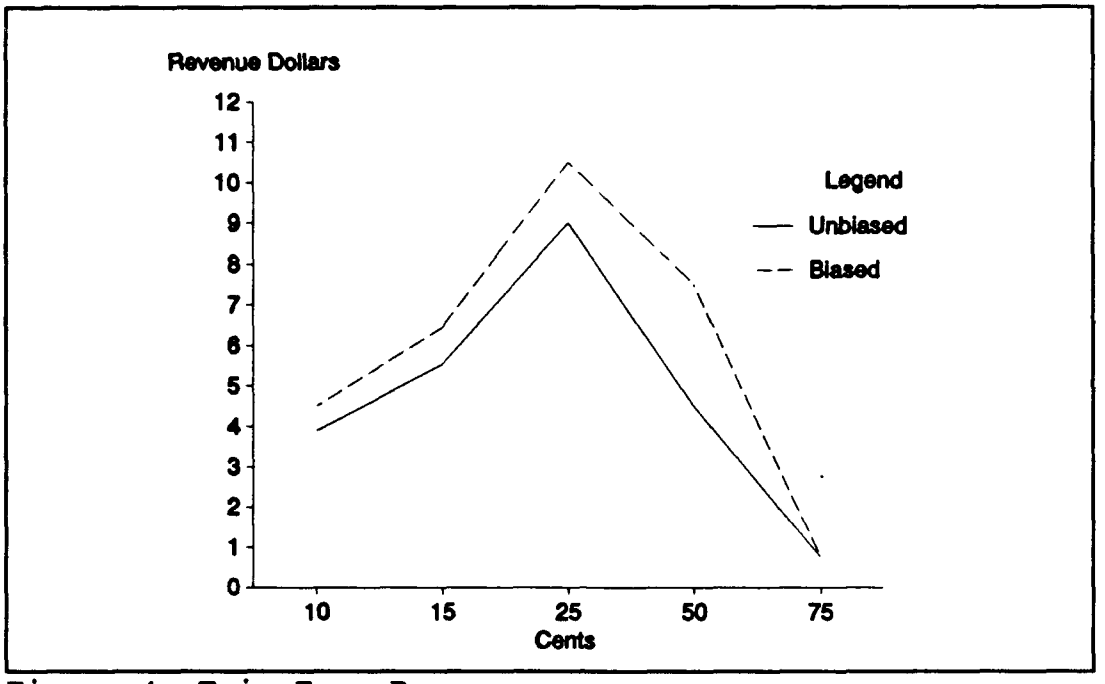

Figure 4. Trip Fare Revenues

cents fare. Even including the biased results, where respondents merely check marked the fifty cent example, a twenty five cents fare would bring in 40% greater revenue. Given these more conservative results, this would equate to a 280% increase in the ridership under the Bus A scheme.

This result is overstated, since about 25% of those that indicated a twenty five cents or greater fare indicated that either they would never ride the bus (survey question four) or indicated they did not think a bus was necessary (question fourteen). After excluding these responses, a twenty five cents fare would still gain an additional 19% in revenues over a fifty cents fare. Assuming a twenty five cents fare and a more comprehensive hourly schedule (i.e., Bus A), what could be the expected weekly ridership and revenue?

3. Projected Ridership

To project ridership numbers, numerous assumptions were made. First, a system identical to Bus A was assumed. Bus A was selected because it proved the most effective and efficient bus system and because it had the most comprehensive schedule. Since the bus schedule ranked as the most important factor from the survey, Bus A seemed the natural selection. In addition, in order to ease comparisons to past bus operations, one bus scheme had to be selected. (As will become apparent in Chapter V, the survey results best support Bus A's schedule.) Finally, actual ridership numbers are a function of price and various other factors, including schedule, reliability, service, and vehicle used. These factors are assumed to be at their optimal value. The analysis below is offered to give the reader a feel for the potential increase in ridership a twenty five cents fare may realize, given acceptable schedule and service.

Based on a 19% revenue increase over the old fifty cents fare, ridership would increase 137%, from 293 weekly paid trips to 697. Using historical ridership patterns from Bus A, this equates to 155 trips per day (Monday through Thursday) by eighty two individuals. Thus, 9.4% of the LMV students would now utilize the bus, up from Bus A's 3.9%.

To ensure this estimate is not overly optimistic, the ridership numbers were also derived from question eleven of the survey; namely, "What percentage of the time would you

ride the bus given acceptable service and price?" Only those who responded that they would ride the bus 50% or more were counted. Further subtracted from this number were all the respondents who indicated that they would never ride the bus (from question four), respondents who did not think LMV should have bus service (question 14) and/or respondents who believed a twenty five cent fare seemed more than they would be willing to spend (as indicated in question twelve). The remaining thirty six personnel represents 41% of the questionnaires returned. Generalized to the population, between 32% and 51% of the LMV population would utilize this bus. Using the more conservative (lower) percentage, about 277 LMV residents could be expected to use the bus service at some time.

To calculate the daily number of personnel using the bus, the probability results of question eleven were multiplied and summed to obtain an overall probability of 55.38%. This number was rounded down to 50% to approximate the daily number of personnel riding the bus, (i.e., 277 x .50 = 139 people). Assuming a 53%/47% morning/afternoon commuting split (as observed from the historical date), approximately 262 fare supported trips could be expected daily. This is almost as many trips in one day as Bus A experienced in one week.

Weekly ridership would be about 1,180 trips, since Friday normally experiences half of a normal day. These numbers would result in over 100% increase in revenues and a

three fold increase in effectiveness when compared to Bus A. Such an increase would require two buses in operation for the first hour, making two runs each. One bus would be required for the remainder of the day. However, this bus would have to double up its runs each hour from 1500 hours until the end of the day.

While these results are quite encouraging, a major unknown is whether the nonrespondents (113 of the 200 surveyed) would have answered in a similar vein. Even assuming that all the nonrespondents on the questionnaire would have indicated no interest in the bus and that the survey results were representative of the total LMV population (877 units), a point estimate of 670 fare trips per week could be anticipated. (877/200 x 36 people = 158 total LMV ridership population. 158 x 0.5 = 79 bus commuters per day. Given 53%/47% morning/afternoon split and only half ridership on Friday, 670 is the resulting weekly ridership.) Even though it is highly unlikely that all 113 nonrespondents would not ride the bus and that this would be representative of the LMV population, there would still be a substantial increase in riders moved per hour compared to Bus A's 293 weekly trips. Therefore, it would be safe to infer that there would have been between 670 to 1,180 fare supported trips per week if Bus A would have reduced its fare to twenty five cents, given acceptable service. The best point estimate would be 697

trips per week (a 137% increase in ridership) with a 19% rise in total revenues.

4. Revenue Projections

Based on the discussion thus far, a twenty five cents one way fare would provide more revenue than a fifty or seventy five cents one way fare. However, the survey results indicated a pass method as the preferred method of payment. By instituting a pass and/or coupon book, in addition to pay as you go, it is assumed that actual revenues will increase despite the discounted pass/coupon book rates because more riders will be attracted. Not offering multiple methods of payment will reduce ridership.

Table 6 below provides an example of the revenues that would be generated, based on the discussion thus far and results of the survey, particularly questions eleven and twelve. This table represents a possible fare structure and assumes the liberal upper bus ridership population of 277 people, as derived previously.

As evident from the table, the 277 personnel, who at varying degrees would ride the bus from/to LMV, have been divided up by method of payment in accordance with the results of question eleven. The type of bus payment a potential bus rider would elect was assumed to be based on his projected use of the bus. A person was then assumed to select a payment option that proved most economical for him.

TABLE 6. REVENUE PROJECTIONS

% Use of Bus	10	20	30	40	50	60	70	80	90	100
% of Riders	25%			45%				30%		
Riders	69			125				83		
Method of Payment	Pay As You Go			Coupon Book (50 tickets)				Quarterly Pass		
Price	$0.25/trip			$10/book				$15/Qtr		
Revenue	$190/Qtr			$1,250/Qtr				$1,245/Qtr		

The total quarterly revenue would amount to $2,685. This fare structure provides for a pay as you go fare of twenty five cents, a 20% discounted book of bus tickets (similar to the current discounted rate for coupon books) and a quarterly pass charge closest to the survey average. Theoretically, this fare structure would represent a 24% reduction in potential revenues compared to the $0.25 pay as you go fare. (1,180 trips per week at twenty five cents times twelve weeks equals $3,540 per quarter.) However, this is based on the bad assumption that ridership would not decrease; it would.

This revenue reduction is overstated, since the quarterly pass holders would not ride the bus all the time and

the potential increase in ridership should potentially out weigh these discounted fares. Since a diverse pay structure appears to be the student preference, it would be most appropriate to implement such and to financially evaluate the bus operations quarterly. In addition, tight monetary controls would have to be instituted, particularly for the pay as you go option.

The fare structure presented here would generate over 50% more revenue than the current fifty cents fare. It is optimistic in that it is based on the upper end of the ridership projections. Unfortunately, even these optimistic revenue projections would not cover all operating costs, if labor costs were included. That being the case, there may be some method to subsidize the bus.

C. BUS SUBSIDIZING PROGRAMS

There are perhaps several ways to subsidize the NPS bus service. Two methods are discussed below, NPS parking fees and an NPS Recycling Program.

1. NPS Parking Fees

Perhaps the easiest way to subsidize the bus, and simultaneously increase bus ridership, is by instituting paid parking. Several command decisions would have to be made, including the number and location of student parking lots that would require payment. Based on the resulting number of paid

parking spaces and projected quarterly bus deficit, a quarterly parking fare could be devised.

For example, the bus system described previously would generate quarterly revenues of $2,685 with a quarterly cost of $5,556 (cost of MWR bus operation). The bus service would experience a $2,871 quarterly loss. To recover this loss, 144 parking spaces in Lot R (see Appendix B) could be reserved at $20 per quarter. The balance of the 199 spaces in Lot R could be held for carpoolers. (Lot R was selected for its prime location. The $20 per quarter fare was established to give the bus quarterly pass, at $15 per quarter, the clear advantage.)

Of course, an infinite number of paid parking schemes could be proposed and implemented, any of which will meet strong student resistance. Though not widely known, paid parking on DOD land is legal and practiced at many locations [Ref. 30]. The main goal of implementing parking guidelines is to make public transportation more appealing and parking for the single occupant automobile less attractive [Ref. 19: p. 5-7]. Free parking is a major incentive to auto use [Ref. 19: p. 9-8]. By establishing paid parking, a disincentive to park is created, more people ride the bus and vehicular traffic from LMV is reduced. The Naval Postgraduate School would find favor with the Monterey Bay Unified Air Pollution Control District, but would find disfavor with the NPS

students. Consequently, a recycling program may be the "politically correct" solution.

2. Recycling Program

Navy regulations require activities to institute recycling programs, the proceeds of which must first be used to cover operation, maintenance and overhead costs incurred in the recycling program. But, "any excess may be used for pollution abatement, energy and safety projects and/or any nonappropriated morale or welfare programs."[Ref. 31: p. 10-4] Specifically, the proceeds from a recycling program will be deposited in a "budget clearing account" which will not be affected by fiscal year end and may be carried over and merged with prior proceeds [Ref. 31: p. 10-7]. The only restriction is that, "not more than 50% of balance may be used at the installation for pollution abatement, energy conservation and occupational safety and health activities."[Ref. 31: p. 10-7] The remaining balance may be transferred to MWR.

Given the 1988 California Clean Air Act, it seems clear that a bus service meets the Navy criteria above. But could a recycling program cover an annual bus deficit of $11,484, as hypothesized above? Could the student population be motivated to recycle with NPS vice other organizations when informed of the ramifications (i.e., subsidize bus service by recycling or pay for parking)?

The recycling subsidizing option is worthy of further study. In fact, another NPS thesis is in the process of examining the financial ramifications of a recycling program at the school. Based on informal discussions with Navy personnel, some shore activities are believed to be reporting proceeds from recycling programs as high as $30,000 per year. Certainly, a strong, active recycling program for NPS/LMV has great financial potential considering the amount of used paper and aluminum cans generated. Aluminum can recycling bins could be installed adjacent to bus stops to highlight its association with the bus and for ease of collection. The recycling potential is apparent, and this method to subsidize the bus would be more conducive to a win/win situation.

D. SUMMARY

There does not appear to be a fare structure that will generate enough revenues to cover all the operating costs of an NPS bus service. However, if the bus driver was an NPS enlisted driver, all the bus schemes could recover actual expenditures. If an enlisted driver was not feasible, the potential to subsidize the bus operation is great.

Of the fares considered, the fare that will generate the most hourly net revenue, on average, is twenty five cents per trip at a fixed cost structure with an enlisted driver. A discounted quarterly fare is the preferred method of payment. With this established fare structure and an acceptable

service, ridership could be expected to increase substantially, easily over 100%.

Great caution was used when projecting ridership and revenues. Secondary sources conveyed this message. A case in point follows.

> In 1986, an express bus route between a Naval Housing area...to the pier area of the Norfolk Naval Base, was initiated after a survey revealed promise for the new route. It was subsequently terminated in a brief 3 months due to ridership rates below the unsubsidized breakeven threshold...similar occurrence at Old Dominion University in May 1988.[Ref. 32]

This example is not intended to void the preceding analysis, but to emphasize that bus systems are not successful by virtue of encouraging survey returns or by popular fares. Bus service requires constant management attention and constancy of purpose. Manipulation of service prices alone will not be very helpful when changes in service characteristics are required to meet market demands [Ref. 33: p. 2]. "While pricing of a product is an important consideration...it is not the most important factor in the consumer's decision ...quality of service is the prime factor."[Ref. 7: p. 60]

Only when all the service factors are optimized is a bus service effective. Even at a twenty five cents fare, no one would ride the bus if the schedule caused them to arrive late for class or the bus routinely failed to show up as scheduled. These service implications will now be addressed.

V. SCHEDULE, ROUTING AND SERVICE

"Although sketchy, the available evidence suggests that selective improvements in transit service can induce more ridership than a moderate or even a large decrease in the fare."[Ref. 33: p. 10] Transportation programs have to be carefully planned and implemented to work [Ref. 19: p. 6-5]. This chapter will focus on the operating characteristics of the NPS bus service and examine those changes most likely to promote increased ridership.

A. SCHEDULE

Without question, the number one factor effecting NPS bus ridership is the schedule. Question six of Appendix A depicts this and is supported by responses from questions four and five. Recall that questions four through six, respectively, asked for reasons why the current bus service was not used more frequently, rated the current service parameters, and ranked the most important factors in electing to become a frequent bus rider. Figure 5 perhaps puts it in perspective best. This Figure represents what the respondents ranked as the number one factor effecting their decision "in electing to become a frequent bus rider." It compares both the results of the raw data and the results when doubtful bus riders were withdrawn from the tabulations (i.e., those that responded

negatively in question number four and/or fourteen of the survey). In both cases, the bus schedule proved to be the most important issue. The relative rankings of all the factors remained unchanged.

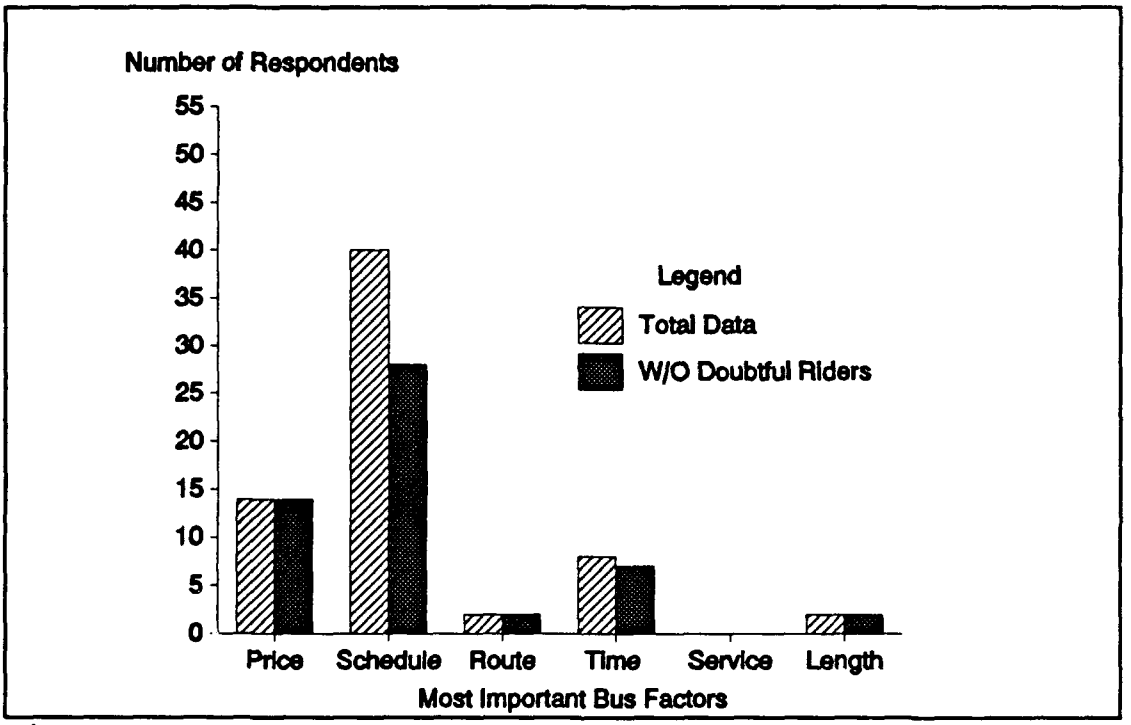

Figure 5. Most Important NPS Bus Factors

Overall, with all the rankings tabulated and averaged, schedule still proved the most dominating factor. Only price was dislodged from its number two position within the relative rankings when the results of question six averaged in the lower order rankings for each factor. In this case, the timeliness factor overcame price.

At the time of this survey, Van C was the bus scheme in effect. Evidently, the existing six run schedule outlined in Chapter II is insufficient to meet the needs of the students. Consequently, the ten run bus schedule of Bus A will be used for further historical analysis in this chapter.

1. Historical Schedule Trends

Table 7 below shows the average percent ridership of Bus A and Bus B throughout the day. It provides the historical data to illustrate the 53%/47% morning/afternoon split alluded to previously. Numbers within the table may not add up due to rounding errors.

TABLE 7. HOURLY PERCENT BUS UTILIZATION

Bus	7*	7	8	9	12	13	14	15	16	17
A	12	29	10	2	2	3	6	10	13	13
B	8	38	9	-	-	-	-	11	27	13
Bus	A.M.(100%)				P.M.(100%)					
A	23	56	18	3	5	7	13	21	27	27
B	15	70	16	-	-	-	-	23	49	28

* All bus runs are on the half hour except the first run.

As is evident, the 0730 bus run in the morning and the 1630 run in the afternoon were the most popular for both Bus

A and Bus B. In fact, in both cases over three fourths of the students rode into school within the first hour. Also, both Bus schemes supported the 53%/47% morning/afternoon split. Bus A worked out to a 52.9%/47.1% split while Bus B averaged out at a 54.2.%/45.8% split. As mentioned previously, a 53%/47% morning/afternoon split was utilized when projecting ridership.

For example, Table 8 below estimates hourly average ridership based on 139 daily bus commuters as derived in Chapter IV. These hourly run ridership projections are based on the historical percent utilization data of Bus A, Table 7 above. Note that 139 daily bus riders (people using the bus) equates to 262 daily trips, using the 53%/47% assumption.

TABLE 8. PROJECTED RIDERS PER RUN

	7*	7	8	9	12	13	14	15	16	17
Riders	32	77	26	4	5	9	16	26	34	33
	139 people (53%)				123 people (47%)					
Maximum Capacity	33	80#	26	5	6	9	17	27	35	34
	144 people (53%)				128 people (47%)					

* All bus runs are on the half hour except the first run.
\# Bus capacity based on 0730 bus run filling two buses, i.e., 44 passenger bus + 36 passenger bus = 80 passengers.

As evident, the upper ridership numbers derived in Chapter IV would be pushing the maximum capacity of the NPS bus service. This is based on NPS using two buses for the first hour and the historical data of Bus A.

It may also be advisable that when only one bus is in service, double runs per hour be made to prevent overcrowding. This would appear to be the case whenever the hourly average bus run would exceed twenty five riders, since ridership variations on the upper end would exceed the bus seating capacity. Multiple runs would reduce the chance of this occurrence and would be advisable within the 0700, 0800, 1500, 1600 and 1700 hours based on the data above.

However, these projections are based on historical data. (While the overall daily ridership number is derived from the survey, the percent distribution across the bus runs was derived from historical data.) Does the survey reveal any changes in scheduling preference that would alter the daily ridership distribution above?

2. Survey results analysis

For the most part, the results of the survey support the historical trends of the past. The most popular hour in the morning, 0700, proved to be the most preferred hour in the survey. Likewise, the most preferred afternoon hour in the survey, 1600, was consistent with the historical data.

A couple schedule shifts did appear; one to a later departure hour from LMV in the morning and another to an earlier return from NPS in the afternoon. The 0800 hours run garnered 42% of the vote as the most preferred morning run, while historical evidence would support less than 10% ridership. Meanwhile, the 1500 hours afternoon run tied the 1600 run as the most preferred afternoon run and, in fact, recorded more secondary responses overall. While the 1500 hours run has always had decent ridership, it historically ran third behind the 1600 and 1700 hours runs.

Table 9 below shows the aggregated results of question seven and nine of the survey. This table reflects the additive responses for desired runs, both enroute to and returning from the NPS main grounds. When combined, the schedule preferences over time level out but still highlight the most popular hours (0700, 0800, 0900, 1500, 1600, 1700). The percentage indicated in the bottom row of the table is based on a sample response of seventy six (i.e., n = 76).

TABLE 9. DESIRED BUS RUN HOURS

	7*	8	9	10	11	12	13	14	15	16	17
#	70	71	65	38	34	53	40	48	75	65	56
%	92	93	86	50	44	70	53	63	99	86	74

* Numbers in top row are abbreviated military hours.

The most striking result from the survey regarding schedule concerned the departure time of the bus from NPS in the afternoon. Specifically, question ten of the survey revealed that students would rather depart at fifteen minutes past the hour vice the current thirty. Figure 6 below graphically displays those results.

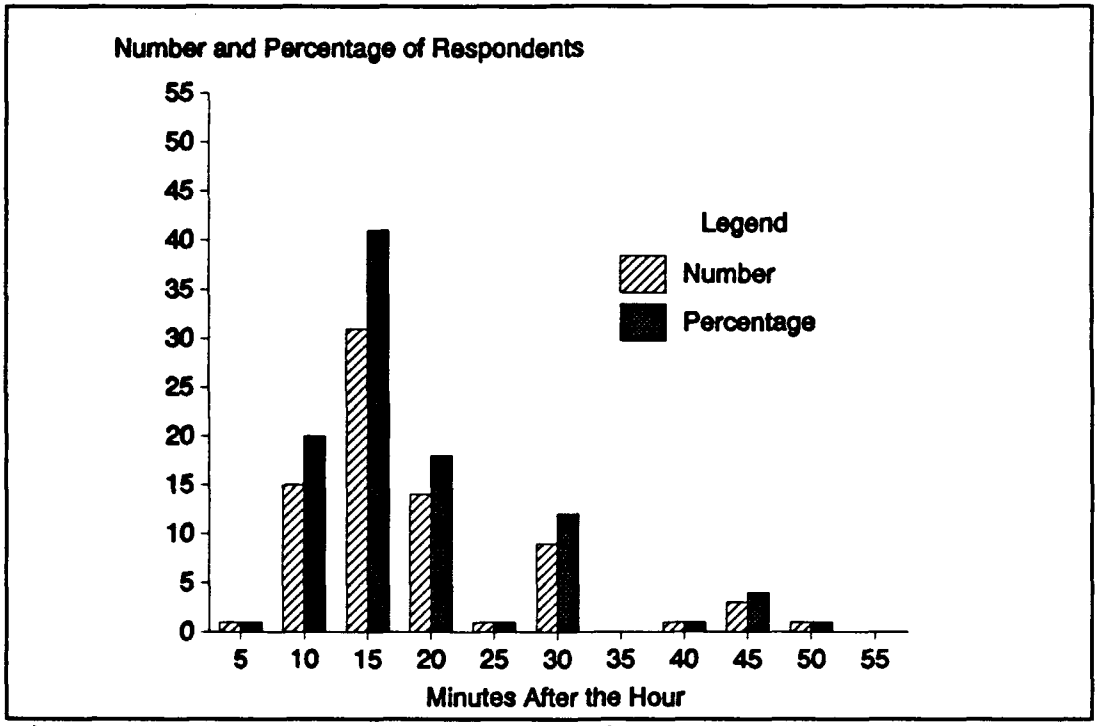

Figure 6. Preferred Departure Time from NPS

As shown, nearly 80% of the students indicated they desire to depart NPS fifteen minutes after the hour, give or take five minutes. This is in contrast to the current schedule which departs thirty minutes after the hour at both

the 1630 and the 1730 run. A departure time of fifteen minutes after the hour would be more aligned with students' schedules, since NPS classes adjourn on the hour. While 12% of the respondents did indicate a desire to depart at thirty minutes past the hour, the distribution above clearly favors an earlier departure time.

Based on the upper ridership projections, the 1500, 1600 and 1700 hours would require double bus runs within those hours. In that instance, the bus could depart on its first run at fifteen minutes past the hour and depart for its second run at forty minutes past the hour. This would allow the first run to complete its twenty to twenty five minute run, and get back just in time for a second pick up. This also would allow any staff or military instructors residing in LMV to use the bus at that time.

The morning departure time from LMV is not as clear. As Figure 7 depicts, there are two prominent spikes, one each at thirty and forty five minutes after the hour. However, the forty five minute response received more support from adjacent times. Consequently, approximately half of the respondents desire to be picked up as late as possible to make their class. A large number desire to be picked up at forty minutes past the hour or later. Since NPS classes start at ten minutes past the hour, this still provides the students ten to fifteen minutes to get to their class after drop off.

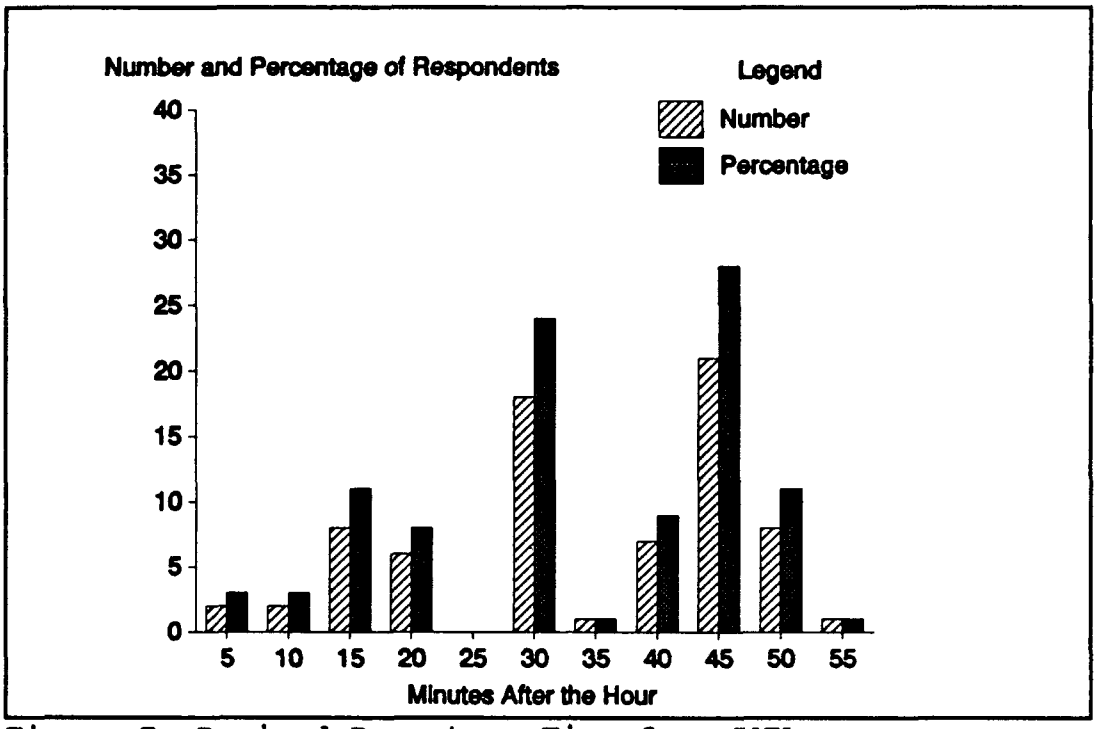

Figure 7. Desired Departure Time from LMV

This preferred pick up time is within five minutes of the existing schedule. Consequently, the bus should start its normal run about five minutes later. Rather than leaving the first stop at thirty minutes past the hour, leave at thirty five minutes past the hour. A revised routing scheme might be in order to meet the preferred pick up times of those residents living closest to NPS. This will be further addressed in the routing section of this chapter.

3. Posted Schedule and Timeliness

Timeliness goes hand and hand with schedule. If there is no definitive schedule, then how is one to know if the bus is on time? Some secondary sources suggest that it is not so much the frequency of service as the proper timing of service

that is important [Ref. 13: p. 52]. Outlined below is an example of the existing schedule format. Adjacent to it is a portion of a proposed schedule format.

Existing Schedule		
Depart NPS	Start LMV Pick Up at Stop One	Arrive NPS
0655	0700	0720
0725	0730	0750
0825	0830	0850
1455	1500	1520
1625	1630	1650
1725	1730	1750

Example Schedule Morning (Route A)	
Depart NPS	xx30
Arrive Stop 1	xx35
Arrive Stop 2	xx36
Arrive Stop 3	xx37
Arrive Stop 4	xx38
Arrive Stop 5	xx39
Arrive Stop 6	xx40

As evident, the example schedule is much more detailed. The hours are left off (xx), delineated by the route. Only the minutes after the hour are outlined. It provides the expected time of arrival at each stop, similar to an intracity bus schedule. As stated earlier, this is very important since the door to door time of commute is a prime consideration for a commuter. It lets the commuter know precisely what time he needs to be at the bus stop. In addition, it provides a benchmark of performance for the bus service. It should be the drivers' prime consideration to reduce the variation between stated pick up time and actual. Never depart a stop early, but just on time or as close as possible.

Timeliness ranked second overall in question six as an important bus service factor. If commuters are assured of a definitive time of pick up, with minimum variation, they are

more likely to ride the bus. The key is to reduce variation in pick up times.

One method to reduce variation is a stable cadre of bus drivers who are adequately trained in their duties. Another practice is to install synchronized digital clocks inside the buses. This prevents variation between drivers' watches and establishes one time standard. Once timeliness has been established with variation of pick up times reduced, ridership will increase.

This thesis will not provide a detailed schedule as outlined above. Although one is highly advisable, it needs to be prepared by the personnel to be held to that schedule, the bus drivers. In addition, since the operating characteristics of a bus are different than that of an automobile, the dry runs that should be made prior to a posted schedule should be made in a bus. This also will help reduce future variation.

B. ROUTE AND LENGTH OF TRIP

The current NPS route and length of trip ranked last among the most important factors for riding the bus. Consequently, little time will be spent on this topic.

Appendix C depicts the existing route and suggests alternative routes. The prime consideration when establishing a route is to make it as direct as possible with respect to origins and destinations [Ref. 13: p. 51]. Given the layout of LMV, this is easier said than done. However, one

shortcoming in the existing route is evident; it starts at the closest point to NPS and works outward. Consequently, those residing by stop one could walk to school more quickly than those simultaneously entering the bus.

One option to amend this flaw is Route A, depicted in Appendix C. It simply completes the loop, adding some additional bus stops through LMV and departing the village along the eastern roadways and back out past stop one. (For clarity, new bus stops are identified with a numeric/alpha designation, i.e., 7A.) This option does not disrupt the existing bus stop locations, adds only two to three minutes to the route, and enters into unchartered territory; an area which is the most densely populated and closest to NPS.

With a revised (five minutes later) pick up schedule, the bus would be traversing this new area between forty five and fifty minutes after the hour, which is prime time. The bus would arrive NPS at fifty five minutes after the hour.

The current route back to LMV is already fairly direct. However, to accommodate the change prompted by Route A, Route B is offered. It makes one minor modification, looping first to the east side of LMV then continuing the old route at stop two. The additional two stops between one and two would be to drop off the residents within the new area.

Finally, in the event that two buses are required for the first hour, Route C in Appendix C is provided. This basically cuts LMV in half to reduce the transit time of those residing

closest to LMV. This route also maximizes use of the existing stop bus locations.

In all the route options depicted, bus stops have been added. This was planned in order to reduce walking distance between the residence and bus stop. The average walking distance should not exceed approximately 750 feet (.14 mile) and stops should be centered in densely populated areas [Ref. 19: p. 7-8]. Simultaneously, an effort was made not to exceed the industry norm of seven stops per mile within an ordinary residential area [Ref. 13: p. 52].

Finally, several different routes are advised throughout the day. Although a bit more confusing, it makes the most of a recognized opportunity, namely, the heavily utilized first hour and the most densely populated portions of LMV.

C. SERVICE

Service is an all encompassing term. In this case, it refers to being able to meet riders needs and expectations, perhaps even exceed them. How reliable is the bus, how clean and comfortable is the vehicle, and how close are the pick up and drop off locations to residences/academic areas? The answers to these and other questions can make or break an otherwise attractive bus service. If left unattended, a bus service will surely fail.

Service ranked fourth out of six in the order of most prominent factors in question six. The NPS bus service seems

to be meeting most commuters' service expectations. The NPS bus stop is at an excellent location within Lot AA adjacent to the academic quadrangle. (Refer to Appendix B.) For the most part, the LMV bus stops were also well situated. However, additional stop locations are advisable to reduce commuters' walking distance.

Some additional service opportunities were reflected in the remarks on the questionnaires. A few people indicated they would only ride the bus during inclement weather or during uniform day.[3] On these days, two buses running during the first hour would be a must if it were not the norm.

Additionally, some students expressed frustration with obtaining bus service after weekly Student Guest Lectures (SGL's). (These lectures are attended by the majority of the student population and normally conclude towards the end of the day, a heavy commuting period.) Two buses standing by at completion of an SGL would also appear a revenue maximizing venture and recommended course of action.

D. MARKETING

"Studies have shown that lack of information leads to apprehension and may act as a riding deterrent."[Ref. 7: p.73]

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[3] The normal attire for NPS students is jacket and tie for men and the equivalent appropriate attire for women. However, one day per month is set aside for the students to wear their respective military uniform.

Ridership will fall off if the residents are not aware of the bus and constantly advised of its existence.

Approxi ately 10% of the survey respondents did not know about the bus. This was indicated in question four of the survey. Generalized to the population, between 3.7% and 16.1% of LMV students are not aware of the existing bus service. How can this be the case and what can be done to correct it?

One case in point is the LMV bus stop signs. Figure 8 below is a picture of a typical bus stop sign in LMV. Although the picture was taken from within eight feet, the sign's intended message, "Bus Stop", is small and unclear. It pales in comparison to the distant street sign.

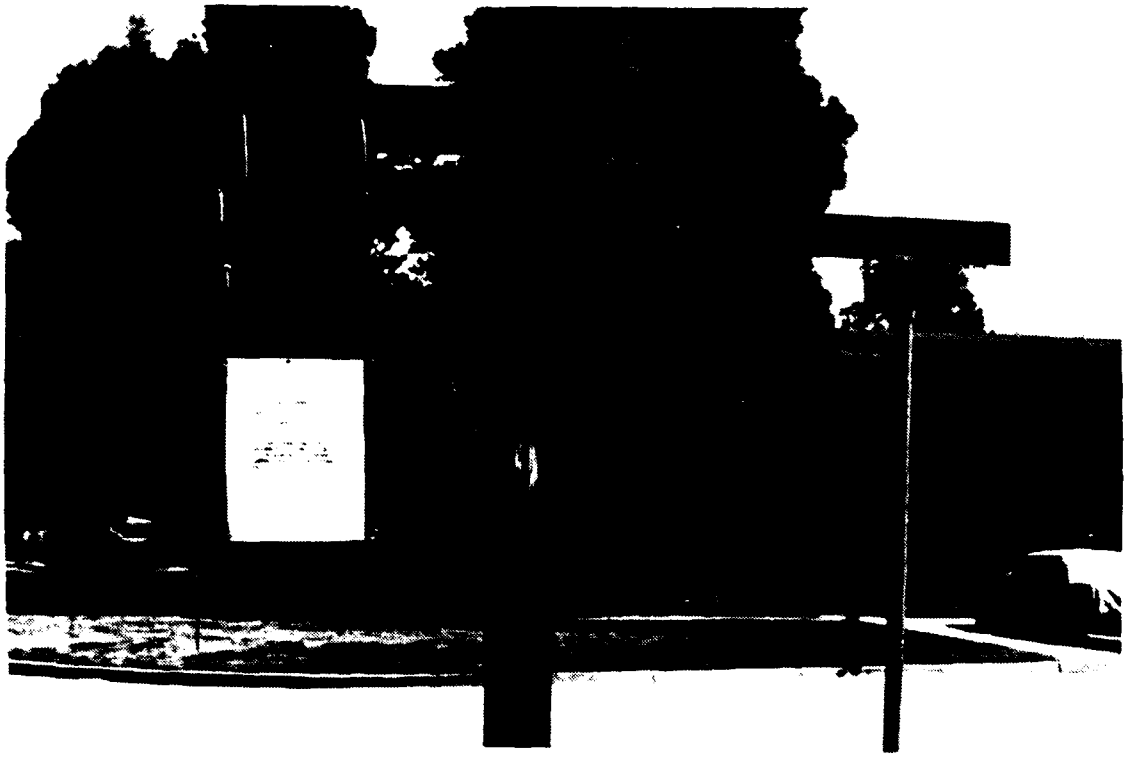


Figure 8. NPS Bus Stop Sign

Rather than take space by posting the bus's schedule, simply modify the sign to read "NPS BUS STOP" in very large, bold, clear lettering. The bus stop number is already indicated on the post. Also, both sides of the sign should convey the same message and be seen from some distance. Currently, only one side of the sign is utilized. The bus stop signs serve as free advertising and a constant reminder of this NPS service.

The foundation of any marketing plan is marketing research [Ref. 7: p. 45]. After solidifying a course of action, a comprehensive marketing plan should be executed. Get the message out. The marketing possibilities are endless. Some marketing suggestions are listed below.

1. "Attack" new students. Provide a pitch for the bus during indoctrination assembly and during respective curriculum in briefs. Put the bus schedule in the hands of new students.

2. Offer free bus service to all new LMV students during their first week of school. Provide that initial incentive to get them on the bus.

3. Publish the schedule throughout NPS. Post it on all curriculum bulletin boards. Have it available on the counter of the NPS library and along with curriculum forms, as well as within the MWR office.

4. Sell bus tickets at the book store during the later part of finals week and for the first week of the quarter. Every student on campus enters this store at that time.

5. Advertise, advertise, advertise. Do articles about the bus service in the school newspaper, "The Quarterdeck," and the Officer's wives magazine, "The Classmate." Relate the bus to energy conservation and environmental efforts. Run a continuous spot on the local cable television channel viewed only in LMV, channel four.

Timing is one other important consideration when instituting this new bus program. As characterized by the survey, current satisfaction for the bus is low. Consequently, it would be most advantageous to institute any major revisions to the bus service (price, schedule, route) simultaneously with parking policy revisions. Specifically, an ideal time to promote the new bus service is concurrent with the completion of NPS construction impinging on parking space and simultaneously with the lifting of the temporary grass parking provision, discussed previously. Another appropriate time to institute bus service revisions would be at the start of an academic quarter.

"Marketing is not merely advertising; it involves the entire business process, determining what the consumer wants, and providing it for him."[Ref. 7: p. 17] Its a dynamic process. People's wants and desires change. Today the schedule proves the most important factor, tomorrow it is anyone's guess. For a bus service to remain financially feasible, it must conform to its changing environment.

E. SUMMARY

Providing a bus service that meets the needs of the consumers is the key to maximizing revenues. The bus price, schedule, route, reliability and advertising are all key

components to its success. Today, revisions to the NPS bus schedule holds the most promise for increasing bus ridership.

The NPS bus schedule should be more comprehensive. It should run during more hours of the day, at least as much as the Bus A scheme of the past. Double hourly runs should be utilized during peak periods and two buses could be run during the first hour of the day. This is the run that will drive the bus ridership for the rest of the day.

Specific bus stop times should be established for each bus stop. These should serve as the benchmark of performance for the bus drivers. Variation in pick up times should be reduced to the maximum extent possible. These definitive schedules should be widely distributed and posted.

Routes should be as direct as possible. They should pass by the most densely populated areas and leave LMV from the closest point to school. They should be flexible and modified to meet the various hourly ridership trends.

Bus stops should be within walking distance from residences and clearly visible from some distance. Their secondary purpose should be as a constant billboard to promote bus utilization. Advertising alone could make or break any public service. There can never be enough.

Is the NPS bus service financially feasible? Can it work? These and other issues are addressed in the closing chapter.

VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

Bus service between La Mesa Village and the Naval Postgraduate School is financially feasible. However, it will not be an easy task. Actual expenditures today can be covered by revenues. But DOD financial policies are changing.

Military labor will be deducted from activity budgets soon. Unfortunately, given bus seating and pricing constraints, revenues will never be able to cover all NPS operating costs, including labor. Labor costs take up the lion's share of any bus service budget. Therefore, an NPS subsidizing program will be required in the future.

The Department of Defense regulations will permit domicile to duty bus service, but only with CNO approval and supported by fares. In addition, an annual revenue/expenditure report will be required. Based on current projections, revenues will continue to cover expenditures as long as military labor is not charged to the activity. In the event fares do not cover costs, it is possible to request a waiver of full fare support to continue bus service. However, all deficits will be borne at the activity level.

There is a definite need for an NPS/LMV bus service. Nearly half the families of LMV only have one vehicle. In

addition, the evolving environmental laws, regulations and ordinances encourage automobile trip reductions to combat air pollution. A high ridership will also help in the effort to conserve energy.

The students of LMV want bus service to NPS. This was reflected by the survey results. Eighty Seven of 200 questionnaires were returned. Nearly three fourths gave a solid vote in favor of bus service. Only eighteen percent said no. Given acceptable service and price, ridership projections were encouraging.

A twenty five cents one way bus price is expected to provide greater average hourly net revenue given a fixed cost structure; more than a fifty or seventy five cents fare. This price is half of the current fifty cents fare, but would bring in at least nineteen percent more revenues. However, the majority of students expressed a desire for bus passes versus pay as you go. Although quarterly bus passes could reduce revenues, the expected increase in ridership should offset this loss.

This bus service will only succeed with constant management attention. The bus drivers cannot do it alone. A dedicated manager should be designated to oversee and monitor this program. Ridership and cost trends should be tracked. Customer complaints should be heard. A bus driver schedule should be promulgated. Revenues should be reconciled against daily bus ridership/cost reports and coupon/cash receipts.

Bus ads, articles and schedules need to be continuously released. This bus service can work.

B. RECOMMENDATIONS

The following recommendations are offered to improve the existing NPS Bus Service.

1. Constancy of Purpose

Establish NPS/LMV bus service as an NPS priority, with an unfaltering commitment to its success. NPS must decide whether an NPS/LMV bus service should be provided. Without top level support, it will never succeed. It would be better to cancel the bus then have an unsupported bus service. There is a need for one, but is the effort worth the benefit?

This bus service will never make money when considering all costs. It could cost NPS as much as $12,000 a year to cover deficits. The purpose of this bus service should be clearly understood. It is a public service to reduce on base parking congestion and promote environmental and energy conservation efforts. Without this shared view, the bus service should be canceled.

2. Establish Base Mass Transit Service

In accordance with the Navy's Transportation Manual (P300), establish a Base Mass Transit Service between La Mesa Village and the Naval Postgraduate School. Submit the required documents as outlined in this publication to obtain

CNO approval and a Transit Facility Control Number. A waiver of fare request may be appropriate at this time.

3. Public Works Bus Service

Transfer responsibility for the bus service back to the Public Works Department (PWD). The Morale, Welfare and Recreation department does not own a bus; PWD owns two. Consequently, MWR is suppose to reimburse NPS for the use of these buses. This additional cost to MWR is one the PWD does not have to bear. In addition, a domicile to duty bus service falls outside MWR's charter.

The Public Works Officer should designate someone within his organization to serve as the command bus manager. This would not be a full time duty, but would be considered a major collateral duty.

4. NPS Enlisted Bus Drivers

Establish a cadre of NPS enlisted bus drivers. At this time, there is no expenditure against station funds for enlisted drivers. This is one area where the NPS bus service will surely fail without top-level support.

The possible procedures and policies applicable to these service members is unlimited. The following questions would need to be resolved.

1. Which NPS department should provide the drivers?
2. What military paygrade is appropriate?

3. How should they be compensated for their extra working hours? Should they be taken off the watchbill? Should they be allowed flexible working hours?

4. Should the bus driver drive the bus the entire day or a portion of the day, with the rest of the day dedicated to normal duties?

One person or one department should not bear the "cost" of this service. Driving a bus from 0645 hours in the morning to 1800 hours in the afternoon makes for a long day. Rather, a cadre of four to six drivers from various departments should share the driving. They should only drive half a day, with the rest of the day spent in their normal department. They should be allowed to arrive one hour later or depart from work one hour earlier (depending on whether they had the morning of afternoon duty) as compensation for their extra time. The more junior they are the better. Perhaps, the newest enlisted service members of the command could be assigned this duty. The options available here are numerous. The end result need only be fair and equitable.

5. Bus Subsidy

Institute an active NPS recycling program to help subsidize the bus, if need be. Concentrate efforts both on the school grounds and throughout LMV. Establish collection points for paper and cans. This program should provide a large subsidy for the bus system.

6. Miscellaneous Bus Equipment

To promote quality service and reliable management information, each bus should have a digital clock installed (each synchronized with the other) and a ridership hand counter. The clocks serve as the benchmark of performance towards meeting the posted schedule and the hand counter would ease the drivers task of keeping accurate hourly ridership counts.

7. Bus Price

The daily one way trip fare should be reduced to twenty five cents. As derived from the survey results, this would result in maximum average hourly net revenue given a fixed cost structure and increase ridership by over 100%.

8. Fare Structure

A multiple fare structure should be devised. This should consist of a discounted quarterly pass at $15, two different coupon books (one twenty ticket book at $4 and another fifty ticket book at $10), and a pay as you go fare at $0.25.

9. Monetary Control

Continue to have MWR sell all bus passes and coupon books and account for all transactions. They are better organized to handle cash transactions and more accessible to students.

It is advisable to install fare boxes for the collection of pay as you go fares. Exact fare should not be required, but drivers should not be expected to make change with cash. They should make change with bus tickets (at a value of $0.25 each). This would also promote future bus utilization.

At least once per day, the bus driver and an MWR representative should reconcile bus tickets and cash received from the prior day's service. Both should sign the daily ridership/cost/revenue report. A copy of this report should be forwarded to the bus manager. Periodically, the bus revenues should be transferred from MWR to the NPS comptroller department.

10. Comprehensive Bus Schedule

Perhaps the most important recommendation is the establishment of a more comprehensive bus schedule. The bus schedule should run at least during the same hours as Bus A (including 0900, 1200, 1300 and 1400 hours), if not more.

The bus schedule should be rewritten to provide detailed bus times for each bus stop. During peak bus hours (0700, 0800, 1500, 1600 and 1700), the bus should make two runs. The morning schedule should focus its pick up times within LMV between thirty five and fifty minutes after the hour. Two buses should be utilized during the first hour of the day, each making two runs, and after weekly SGLs. The

prime afternoon departure time from NPS should be fifteen minutes after the hour.

11. Route and Bus Stops

The minor adjustments in bus routing depicted in Appendix C should be implemented. This would attract additional bus riders from the most populated areas of LMV by making their commute to and from NPS more direct. The two buses running during the first hour would each have their own route, as depicted by Route C in Appendix C.

Three new bus stops should be installed along these modified bus routes. These bus stops will reduce commuters' walking distance. They have been situated in densely populated areas and/or where the distance to a bus stop from a residence exceeded the industry standard of 750 feet. Further review should be conducted on existing stops to see if they could be better situated.

12. Marketing

Establish and execute a bus marketing plan. Advertise the plan as a new bus system; divorce it from the old. Execute the plan simultaneously with the lifting of the temporary grass parking policy and/or at the start of an academic quarter.

Sell the bus to the new students. Pitch the bus at all indoctrinations. Allow them one free week of bus service. If possible, put bus passes and coupon books on sale at the

book store at the end of finals week and during the first week of school. Distribute the bus schedule throughout NPS. Post it on curriculum bulletin boards. Make it available on the NPS library counter and MWR office. Air it on the LMV cable channel. Advertise, advertise, advertise!

13. Future Studies

This thesis should not be the end all for the NPS/LMV bus. Regular review of this service is in order.

There is a high turn over in La Mesa Village. People's tastes and preferences change. Changes within the bus system itself will highlight other weak areas that will need management attention. Like any business, this bus service will have to remain sensitive to its consumers. A periodic marketing survey, perhaps annually, should accomplish this. A more comprehensive review of the routing could augment this study.

C. SUMMARY

The NPS Bus service will work. However, it will require, constant, innovative management attention. "Unless financial solvency is maintained, transit service is bound to deteriorate."[Ref. 13: p. 51] Likewise, unless quality of service is maintained, ridership will deteriorate.

LMV students will ride the bus. But, as in any service industry, it must be on their terms.

APPENDIX A. NPS BUS SURVEY RESULTS

Should NPS provide bus service for La Mesa Village students?

In conjunction with a thesis study, and as required by DOD Regulation 4500.36-R, an annual survey is required to document the need and demand for base bus service. Accordingly, please take a moment of your time to answer this questionnaire and return to NPS 43 in the preaddressed/stamped envelope. Thank you.

QUESTIONNAIRE: (Please return by March 6, 1992)

Address (optional) _____ Rank _____
Curriculum (Name/No.) _____
Number of cars owned and garaged within La Mesa _____
Currently, your principle source of transp. to NPS _____

PRELIMINARY DATA: (87 of 200 questionnaires were returned)

ADDRESS REPLIES			
	Provided	No Reply	Total
Number	49	38	n=87
Percent	56.3	43.7	100

RANK						
	LTJG	LT	LCDR	CDR	TOTAL	NO REPLY
Number	2	53	24	3	n=82	5
Percent	2.4	64.6	29.3	3.7	100	

NUMBER OF CARS				
	One	Two+	Total	No Reply
Number	36	50	n=86	1
Percent	41.9	58.1	100	

PRINCIPLE SOURCE OF TRANSPORTATION TO NPS								
	Car	Walk	Bike	Motor Bike	Car-pool	Bus	Total	No Reply
NO.	38	21	13	3	2	3	n=80	7
%	47.5	26.3	16.3	3.8	2.5	3.8	100.2	

1. I currently ride the bus (circle one):

Always Frequently Often Sometimes Never

	Always	Freq	Often	Sometimes	Never	Total
No.	1	4	2	16	64	n=87
%	1.0	4.6	2.3	18.4	73.6	100

2. I am satisfied with current bus service: Yes No N/A

	Yes	No	Total	N/A
Number	13	24	n=37	50
Percent	35.1	64.9	100	

3. I would rate the parking facilities at NPS as (circle one):

Excellent Very Good Good Fair Poor

	Excellent	Very Good	Good	Fair	Poor	Total	No Reply
No.	1	2	6	39	38	n=86	1
%	1.2	2.0	7.0	45.3	44.2	99.7	

4. The reason(s) I don't ride the bus more frequently is because (Circle all those that apply):

a. The price is too high
b. The schedule is not suited to my needs
c. The route is not suited to my needs
d. Not timely; unreliable service
e. Did not know about bus service; poor marketing
f. Will never ride bus; prefer another form of transp.

	Prce	Schd	Rte	Unrel	Poor Advt	Never ride	TOT	No Reply
No	25	48	8	10	8	27	n=81	6
%	30.9	59.3	9.9	12.3	9.9	33.3	*155	

* Received 126 responses; or 1.55 responses per person

5. Rate the following factors for the current bus service (skip this question if you have never ridden bus):

	Excellent	Very good	Good	Fair	Poor
a. Price	1	2	3	4	5
b. Schedule	1	2	3	4	5
c. Routing	1	2	3	4	5
d. Timely	1	2	3	4	5
e. Bus/Van	1	2	3	4	5
f. Ride Lnth	1	2	3	4	5

	Excel (1)	VG (2)	Good (3)	Fair (4)	Poor (5)	Total (n)	Avg
Price	1	2	7	6	5	21	3.57
Schd	0	1	5	10	6	22	3.95
Route	5	5	9	3	0	22	2.45
Time	1	6	11	3	3	24	3.04
Veh	0	3	9	5	2	19	3.32
Lngth	3	8	9	2	0	22	2.45

Note: Only 23 personnel should have responded since only those currently riding bus were to answer

6. The most important factors for me in electing to become a frequent bus rider would be (please rank in order of importance, 1 being the highest):

___ Price ___ Schedule ___ Route ___ Timeliness
___ Service ___ Length of ride ___ Other_____

Rank	Price	Schd	Rte	Time	Srvc	Lngth	Other
1	14	40	2	8	0	2	2
2	18	14	8	15	1	1	0
3	9	4	2	20	16	3	0
4	8	4	7	7	15	6	1
5	5	0	17	1	6	14	0
6	5	0	10	1	8	16	0
7	0	0	0	0	0	2	1
Total (n)	59	62	46	52	46	44	4
Avg	2.78	1.55	4.28	2.63	4.09	4.93	
Rnkng	3	1	5	2	4	6	

7. Circle all the hours within which you would like to see bus service run <u>from La Mesa to NPS</u> (place an * above the <u>one</u> most preferred time):

0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700
Other_____
(Ex: One might circle 0700, 0800 and 0900; * above 0700.)

	7	8	9	10	11	12	13	14	15	16	17	TO	NR
#	63	64	55	26	19	24	18	15	16	8	5	76	11
%	83	84	72	34	25	32	24	20	21	11	7		

MOST PREFERRED TIME

	7	8	9	10	11	12	13	14	15	16	17	TO	NR
#	35	29	4	0	0	1	1	0	1	1	0	69	18
%	51	42	6	0	0	1	1	0	1	1	0	10	

"TO" means total, and "NR" refers to no reply

8. How many minutes after the hour would you most prefer to be picked up <u>going from La Mesa to NPS</u> (circle one):

5 10 15 20 25 30 35 40 45 50 55

	0	5	10	15	20	25	30	35	40	45	50	55	T	NR
#	2	2	2	8	6	0	18	1	7	21	8	1	76	11
%	3	3	3	11	8	0	24	1	9	28	11	1		

"T" means total, and "NR" refers to no reply

9. Circle all the hours within you would like to see bus service run <u>from NPS to La Mesa</u> (place an * above the <u>one</u> most preferred time):

0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700
Other_____

	7	8	9	10	11	12	13	14	15	16	17	18	T	NR
#	7	7	10	12	15	29	22	33	59	57	51	4	74	13
%	9	9	14	16	20	39	30	47	80	77	69	5		

MOST PREFERRED TIME

	7	8	9	10	11	12	13	14	15	16	17	18	T	NR
#	2	0	1	0	0	2	1	0	15	15	8	2	37	40
%	5	0	3	0	0	5	3	0	41	41	22	5		

10. How many minutes after the hour would you most prefer to be picked up <u>going from NPS to La Mesa</u> (circle one):

5 10 15 20 25 30 35 40 45 50 55

	0	5	10	15	20	25	30	35	40	45	50	55	T	NR
#	0	1	15	31	14	1	9	0	1	3	1	0	76	11
%	0	1	20	41	18	1	12	0	1	4	1	0		

11. Approximately, what percentage of the time would you ride the bus given acceptable service and price (circle one):

10 20 30 40 50 60 70 80 90 100

	10	20	30	40	50	60	70	80	90	100	T	NR
#	12	3	1	3	14	3	9	9	6	5	65	14
%	18	5	1	5	21	5	14	14	9	8	99	

12. Given an acceptable bus service (i.e., schedule, routing, timeliness, etc.) what price would you be willing to pay as outlined below (fill in each line):

		Example:
a. Daily (one way):	_____	($.50/trip)
b. Weekly:	_____	($2/week)
c. Monthly:	_____	($5/month)
d. By quarter:	_____	($10/qtr)

(Note: If blank line was checked instead of filled in, the adjacent example monetary figure was assumed to have biased the answer. Unbiased data deletes check marked answers.)

DAILY FARE IN CENTS: UNBIASED DATA

	0	10	15	25	*50	75	T	NR
No.	2	2	1	27	8	1	41	46
%	5	5	2	66	20	2	100	

DAILY FARE IN CENTS: BIASED DATA

	0	10	15	25	*50	75	T	NR
No.	2	2	1	27	14	1	47	40
%	4	4	2	57	30	2	100	

* Indicates price given as example in question

WEEKLY FARE IN DOLLARS: UNBIASED DATA

	0	.40	1	1.25	1.50	*2	2.50	4	T	NR
#	3	1	6	3	1	16	3	2	35	52
%	9	3	17	9	3	46	9	6	102	

WEEKLY FARE IN DOLLARS: BIASED DATA

	0	.40	1	1.25	1.50	*2	2.50	4	T	NR
#	3	1	6	3	1	21	3	2	40	47
%	8	3	15	8	3	53	8	5	103	

* Indicates price given as example in question

MONTHLY FARE IN DOLLARS: UNBIASED DATA

	0	2	3	4	*5	6	7	8	10	15	20	T	NR
#	4	2	2	2	17	5	2	2	5	1	1	43	44
%	9	5	5	5	40	12	5	5	12	2	2		

MONTHLY FARE IN DOLLARS: BIASED DATA

	0	2	3	4	*5	6	7	8	10	15	20	T	NR
#	4	2	2	2	23	5	2	2	5	1	1	43	44
%	8	4	4	4	47	10	4	4	10	2	2	99	

* Indicates price given as example in question

QUARTERLY FARE IN DOLLARS: UNBIASED DATA

	0	5	7	*10	12	12.5	15	20	25	30	T	NR
#	4	4	1	10	1	1	9	6	3	2	41	46
%	9	9	2	24	2	2	22	15	7	5	97	

QUARTERLY FARE IN DOLLARS: BIASED DATA

	0	5	7	*10	12	12.5	15	20	25	30	T	NR
#	4	4	1	26	1	1	9	6	3	2	41	46
%	7	7	2	46	2	2	16	11	5	4		

* Indicates price given as example in question

13. What method would you most prefer to pay for the bus (circle one)?

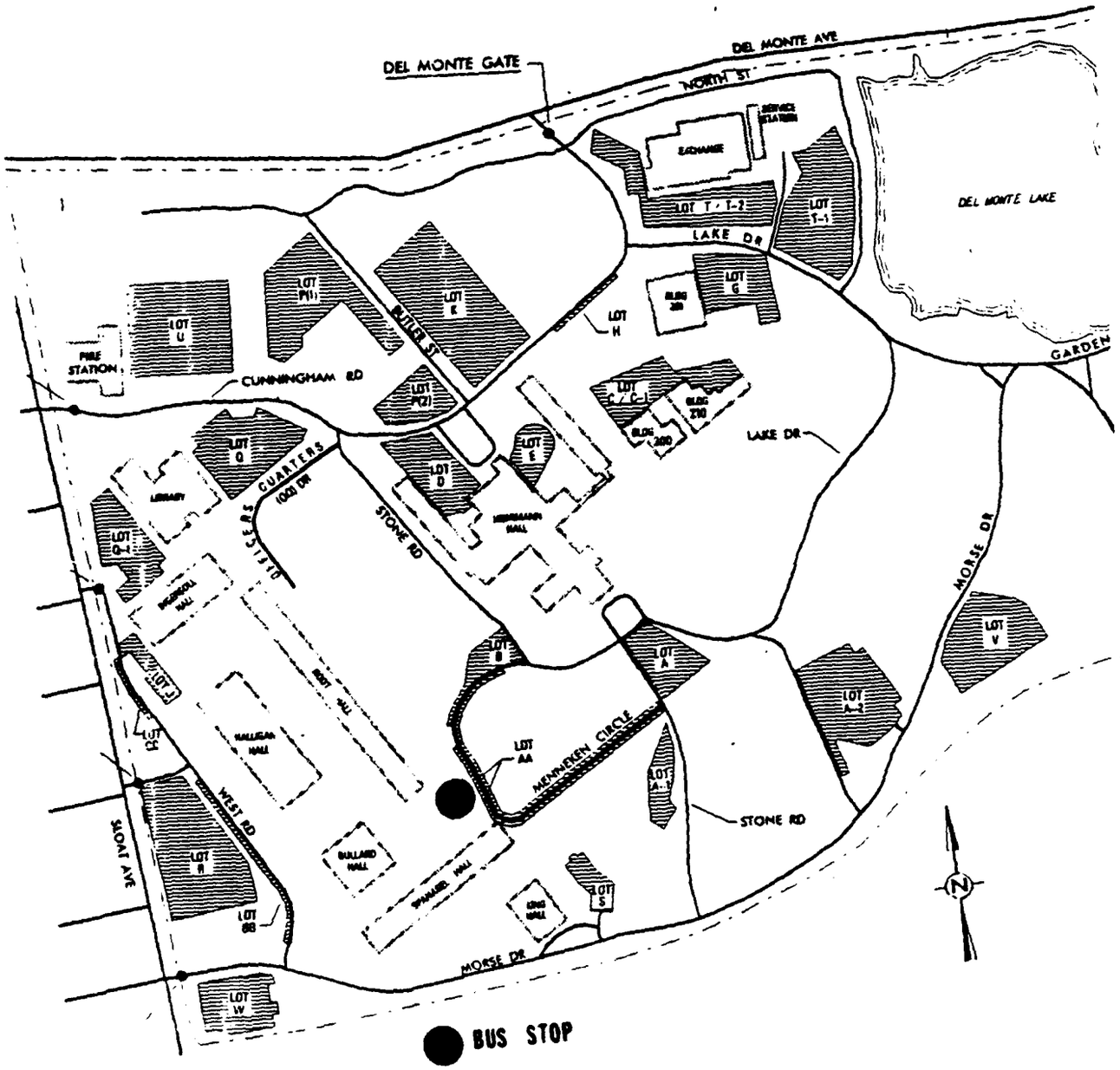
a. Pay as you go
b. Coupon book of bus tickets
c. Monthly pass
d. Quarterly pass
e. Other_____

	Pay As Go	Coupon	Monthly	Qtr	Other	TOT	NR
No.	14	16	18	39	4	77	10
%	18.2	20.8	23.4	50.6	5.2		

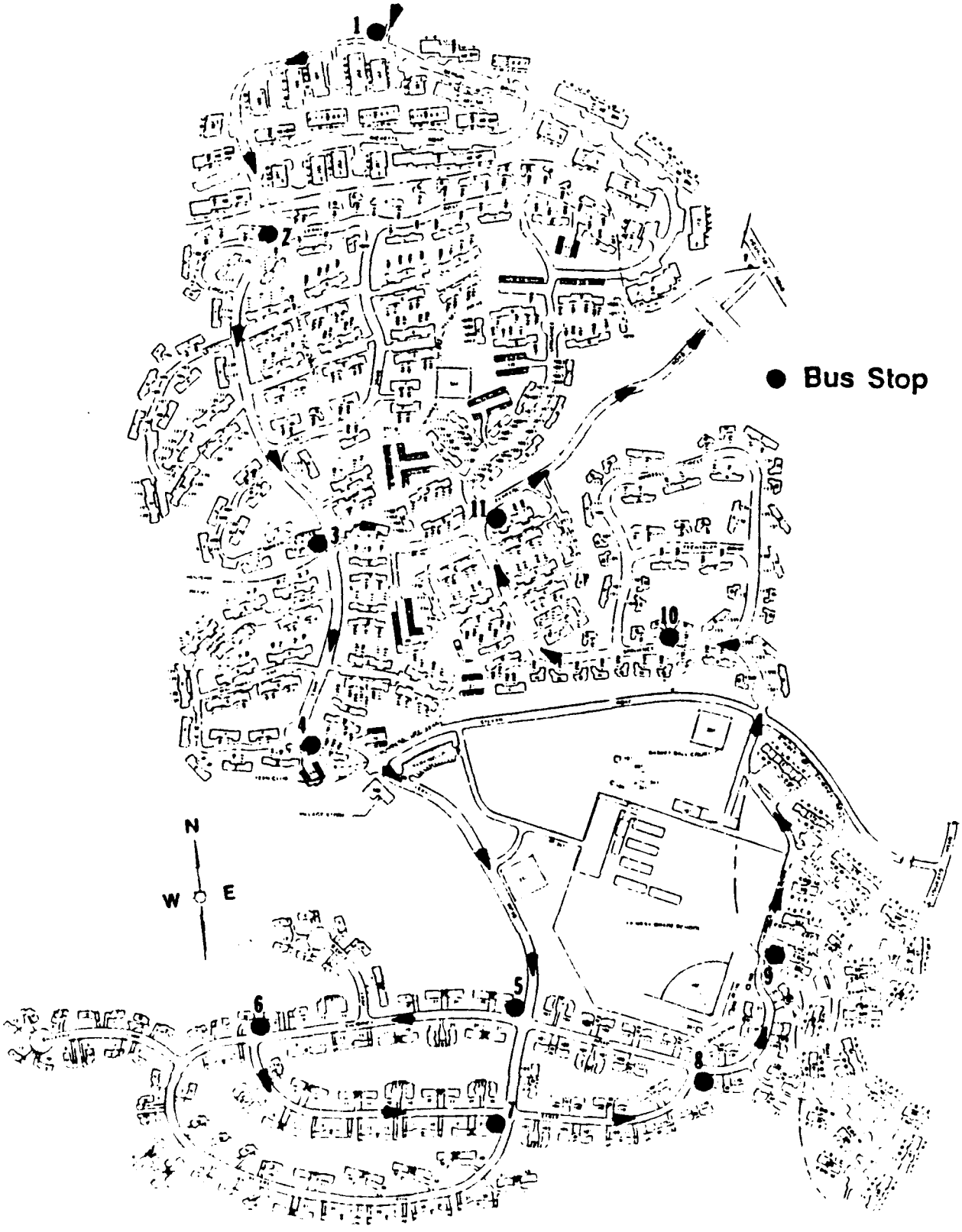
14. Do you think we should have bus service from La Mesa Village to NPS, and if so what improvements do you think should be made to the current service? (Remarks)

	Yes	So/So	No	Total	No Reply
No.	55	7	14	n=76	11
%	72.4	9.2	18.4	100	

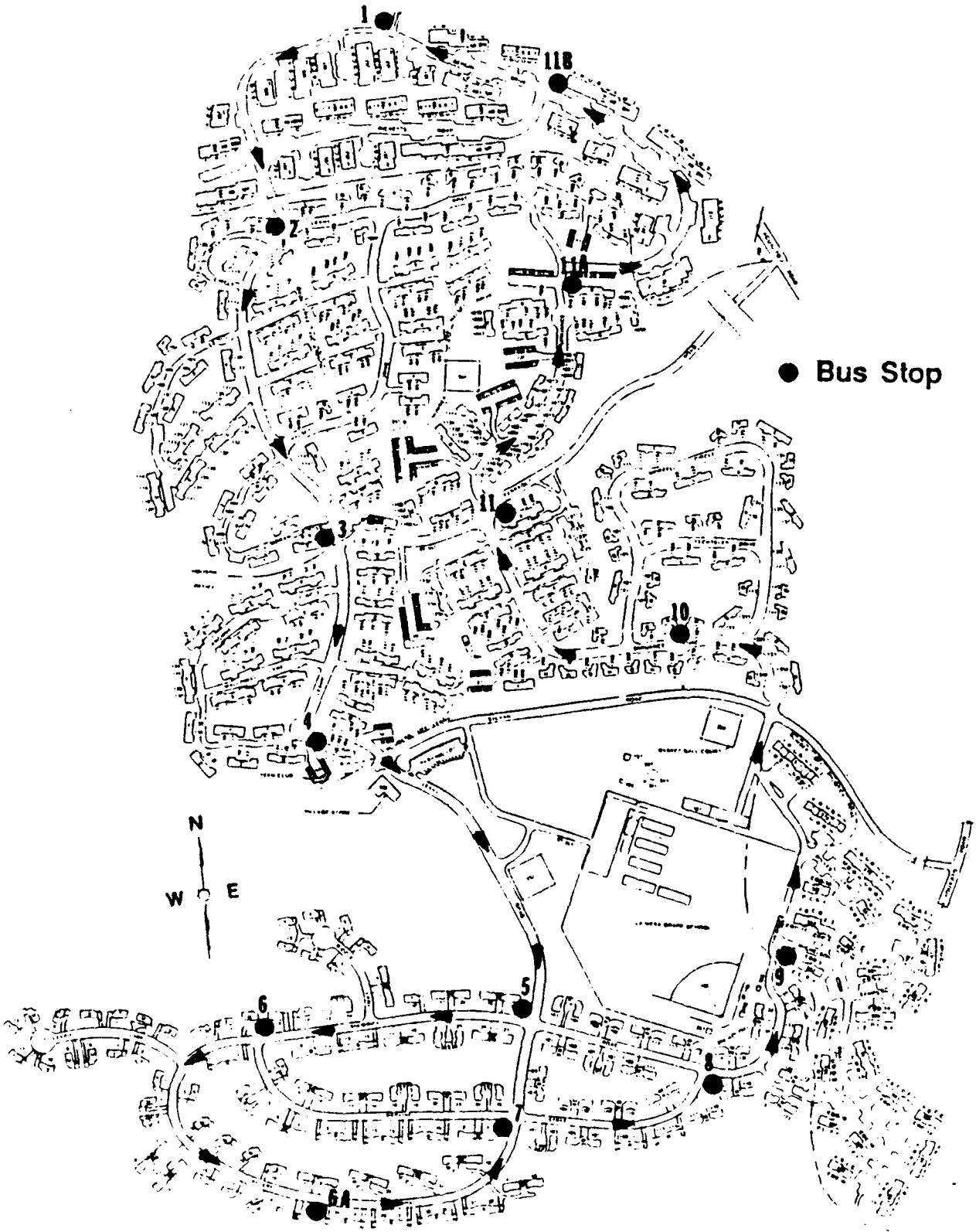
APPENDIX B. NPS PARKING LOT LOCATIONS



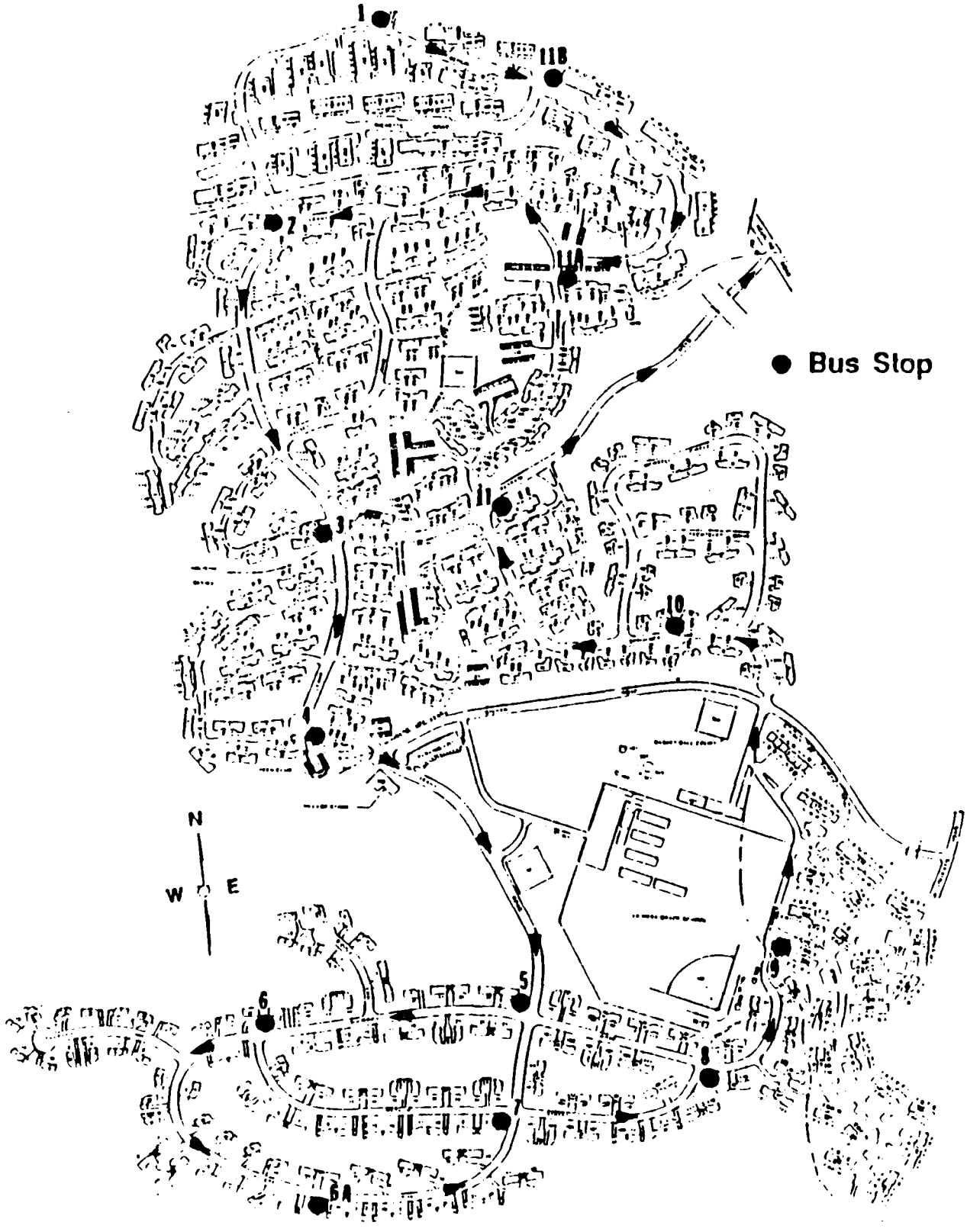
APPENDIX C. LMV CURRENT AND MODIFIED BUS ROUTES



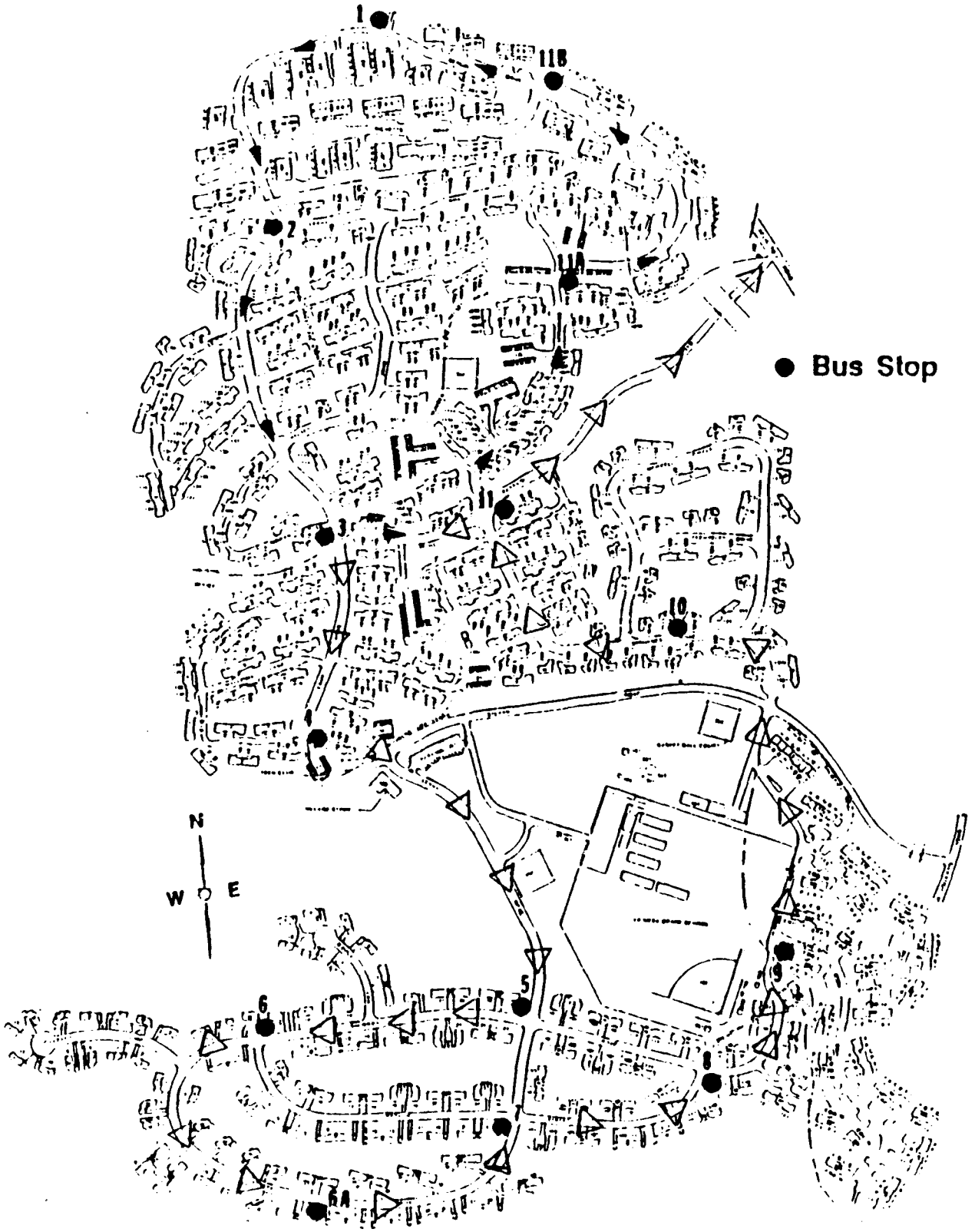
Route A: Modified Morning Bus Route



Route B: Modified Afternoon Bus Route



Route C: Modified First Hour Dual Bus Routes



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